THE

POPULAR SCIENCE MONTHLY.

MAY, 1887.

THE NATURAL *VERSUS* THE SUPERNATURAL.

By JOHN BURROUGHS.

OUR theological professors make a mistake when they think they have weakened or parried the objections of science to their doctrines by pointing to the fact that science is constantly revising or reversing its own conclusions; that what was deemed good science at one time is found to be false science at another. "This modern infallibility which men call science" is a phrase used by Rev. Dr. Jenkins in criticising in the "Evangelist" my paper on "Science and Theology" in the December number of this magazine.

"We who are yet upon the safe side of the ministerial dead-line," he says, "can remember when it was scientific to assert the diverse origin of the race 'from four or six pairs' of progenitors; and we have come to the day in which science will not leave us as much as Adam and Eve for a beginning. We have learned the igneous origin of granite, just in time to be commanded to unlearn it, and substitute an aqueous origin." And the conclusion, therefore, is that science is discredited, and that he who builds upon it plants his house upon the sands. But science makes no claim to infallibility; it leaves that claim to be made by theology. "This shifting of positions and this changing of results" but marks its growth, its development; and it is precisely this active and inquiring spirit, this readiness to correct its errors, and this eagerness to reach a larger generalization, that makes it the enemy of the traditional theology. It abandoned the Ptolemaic system of astronomy for the Copernican, because the latter was found to be the most complete generalization; but theology still adheres to its Ptolemaic system of things. To seek to discredit science because it has made mistakes, and has had to unlearn many things, is to deny the very principle of progress; it is to reflect upon the child because he grows into a man. The main outlines of the physical universe sci-

ence has undoubtedly finally settled; the great facts of astronomy and geology are not to be reversed or set aside. It is only in the details, the filling in of the picture, that errors are still likely to occur. No, what theology has to fear, and what is working such mischief with it, is not the "infallibility" of science, but it is the scientific spirit, the spirit that demands complete verification, that applies past experience to new problems, that sees that immutable laws lie at the bottom of all phenomena, and that is skeptical of all exceptions to the logical course of events until they are irrefragably proved.

Science is ignorant enough, without doubt, about many things. After it has done its best, the mystery of creation is as deep as before. But what it has taught the race, and what the race can never unlearn, is, that the sequence of cause and effect is inviolable, that the order of the physical universe is rational, that creation is not an historical event but a perpetual process, that there is no failure and no disorder in Nature, and that to approximate to anything like a right understanding of things the personal, or, if I may coin the word, the *anthrocentric*, point of view must be abandoned.

Dr. Jenkins is unfortunate in confronting the kind of "exceptions" which I aver science can not recognize with the fact that water, in opposition to all other material substances, *expands* under a certain degree of cold. But is there any known exception to this law of water? Has water ever been known to reverse this process in freezing? If so, the exception would indeed stagger science; it would be a miracle. A child born of a woman, but without an earthly father, and of a superhuman species, is the kind of exception which I averred science can not recognize; but does this bear any analogy to the exceptional behavior of water while freezing, when compared with other substances? It used to be believed that in every animal that possessed a circulation the blood always took one definite and invariable direction, but, in 1824, Huxley says, it was discovered that a class of animals called *Ascidians* furnished an exception; the heart of these animals, after beating a certain number of times, stops, and then begins to beat in the opposite way, so as to reverse the course of the blood, which returns by-and-by to its original direction. Such an exception does not disturb the man of science; it only teaches him greater caution in making his deductions. But if one Ascidian, and but *one*, could be found whose heart beat like that of other animals, that would be a puzzle to him. Or if one comet, and only one, should appear carrying its tail toward the sun instead of from it, cometary astronomy would be reduced to chaos. A floating feather is no exception to the law of gravitation, but a floating stone and a falling feather would be an exception. Science as well as experience finds exceptions to general rules everywhere, but these exceptions are constant and as strictly the result of natural law as anything else. Faith in the continuity of Nature, upon which the scientist builds, no less than every man in the conduct

of his life, does not mean sameness or identity of all physical processes, but it means identity of these processes under like conditions. Given the same conditions, and the same results *always* follow. Water obeys its laws under low temperature, and iron its. It is not long since that the Bishop of Carlisle urged as an argument against the uniformity of Nature the fact that the weather is changeable! If his lordship could have shown that the laws which govern the formation of clouds, and the precipitation of rain and snow are changeable, or ever work inversely, he would have made out his case. The fathers of the Church believed that the flesh of the peacock never decayed. St. Augustine said he had ascertained by experiment that this is a fact. If this were so, it would indeed be a remarkable exception; but the man of science would at once set about ascertaining its natural cause, without for one moment attributing it to a supernatural one. But without trying the experiment ourselves, does any sane man to-day doubt that either the saint deceived himself, or else that he was not honest? His statement is incredible, because it contradicts all the rest of our knowledge relating to the decomposition of animal tissue.

I suppose the last thing our fathers would have thought of doing, would have been to try to reconcile their conception of Christianity with their stores of natural knowledge. They did not feel the need, which we to-day feel so keenly, of any such reconciliation. They cherished their faith as something apart, something not founded in the order of this world, something to which science and all that pertains to the "natural man" are necessarily strangers. The order of this world is carnal; it is full of evil, and is separated by an impassable gulf from the sacred and the divine. A vast number of most excellent and pious people still feel in this way about their religious belief; it is all the more sacred and precious to them because it has no relation to the natural course of mundane things. It forms for them an escape from the humdrum, from the failures, and from the materialism of life. Who can recall without deepest sympathy and love the religious beliefs and observances of the many simple and credulous people he has known in his youth, perhaps of his own parents or grandparents, with their fervid piety but merciless creeds, their faith in their church and in the saving power of its sacraments, their unquestioning belief in the literal truth of the Bible, every word of it—the Fall, the Flood, the miracles, and all? What a refuge their faith was to them in times of trouble; what an avenue of escape into spiritual and ideal regions! It saved them; why can it not save us? For the simple reason that it is no longer credible to us: we are born into another world; we can not believe the old creed, try we never so hard. It was adequate to their knowledge, to their development, but it is not adequate to ours. The old terms and symbols satisfied them, but they are fast becoming obsolete to us. The whole aspect of the universe has changed. But our salvation is to be had upon essentially the same

terms as our fathers'—namely, by fidelity to what we see and feel to be true.

"Few minds in earnest," says Cardinal Newman, "can remain at ease without some sort of rational grounds for their religious belief." But it is equally true that half-formed, half-developed minds, which means the great mass of the people of any age, rather draw back from exposing their faith to a light so common, so secular as that of reason. Plutarch quotes Sophocles as saying that the Deity is

"Easy to wise men, who can truth discern,"

but adds that the vulgar look with high veneration upon whatever is extravagant and extraordinary, and conceive a more than common sanctity to lie concealed under the veil of obscurity. The average mind clings to the mysterious, the supernatural. Goethe, as lately quoted by Matthew Arnold, said those who have science and art have religion; and added, let those who have not science and art have religion, that is, let them have the popular faith; let them have this escape, because the others are closed to them. Without any hold upon the ideal, or any insight into the beauty and fitness of things, the people turn from the tedium and the grossness and prosiness of daily life, to look for the divine, the sacred, the saving, in the wonderful, the miraculous, and in that which baffles reason. The disciples of Jesus thought of the kingdom of heaven as some external condition of splendor, and pomp, and power which was to be ushered in by-and-by by hosts of trumpeting angels, and the Son of man in great glory, riding upon the clouds, and not for one moment as the still small voice within them. To find the divine and the helpful in the mean and familiar, to find religion without the aid of any supernatural machinery, to see the spiritual, the eternal life in and through the life that now is—in short, to see the rude, prosy earth as a star in the heavens, like the rest, is indeed the lesson of all others the hardest to learn.

But we must learn it sooner or later. There surely comes a time when the mind perceives that this world is the work of God also and not of devils, and that in the order of Nature we may behold the ways of the Eternal; in fact, that God is here and now in the humblest and most familiar fact, as sleepless and active as ever he was in old Judea. This perception has come and is coming to more minds to-day than ever before—this perception of the modernness of God, of the modernness of inspiration, of the modernness of religion; that there was never any more revelation than there is now, never any more miracles or signs and wonders, never any more conversing of God with man, never any more Garden of Eden, or fall of Adam, or thunder of Sinai, or ministering angels, etc.; in fact, that these things are not historical events, but inward experiences and perceptions perpetually renewed or typified in the growth of the race. This is the modern gospel; this is the one vital and formative religious thought of modern times.

The mind that has fully opened to this perception no longer divorces its faith from its reason, no longer rests in the idea of a dualism in creation or opposition between God and the world, and can not feel at ease until its religious belief is in harmony with its natural knowledge. The two must not be at war. What we hope for, what we aspire to, must be consistent with what we know. Faith and science must, indeed, go hand in hand. The conception of religion as a miraculous scheme for man's redemption interpolated into history, God's original design with reference to man having miscarried, is entirely undermined and overthrown by the perception of the unity and consistency of creation as revealed by science.

Who does not see that it adds vastly to the credibility of a doctrine or theory to find that it fits in with other things, that it is not an exception or an isolated circumstance, but is in a line with facts and principles of the truth of which we are already assured? Suppose the theory of Christianity, as popularly held, had something like the breadth of application, or the same warrant and basis in the constitution of things as has, say, the theory of evolution or the doctrine of the conservation of energy; or suppose the dogma of vicarious atonement pleased the mind and harmonized with our sense of the fitness of creation like the modern doctrine of embryology, namely, that embryology is a repetition of past history, that every animal in its development from the egg assumes successively, though briefly, all the forms through which its ancestors have come in the course of the long stretch of geological ages, should we not all at once accept it as true? Would there ever have been any doubters and skeptics? I think not. It is because these things have no such warrant and basis, no such agreement with our perception of the order of the world, that doubters and skeptics exist; it is because they break completely with all the rest of our knowledge of creation.

There is a very marked activity in the theological mind of to-day which has for its end the bridging over of the gulf which exists between natural and what is called "revealed" truth. Half a dozen recent works might be named of which this is the principal aim. That eloquent preacher, Frederick W. Robinson, sought in one of his sermons to give a natural basis to the dogma of vicarious sacrifice, perhaps the most incredible dogma in the popular creed. See, says the eloquent divine, how the mineral must decay before the vegetable can grow; how the vegetable must die before the animal can live; how the animal must perish before we can have roast beef for our dinner. The dove is stricken down by the hawk, the deer by the lion, the winged fish falls into the jaws of the dolphin. "It is the solemn law of vicarious sacrifice again"; and so still higher. "The anguish of the mother is the condition of the child's life." Every civilization is founded upon the labors and sufferings of those who went before. When this law of self-sacrifice is consciously obeyed it becomes the

highest moral virtue and reaches heroism. Now, all this is true; it is a part of our natural knowledge. But it is not vicarious sacrifice; it is not sacrifice at all in the true sense. It is the order of the succession of life in Nature. The living present is always reared upon the dead past. Not only men, but races and nations—

> "May rise by stepping-stones of their dead selves
> To higher things."

The six noble citizens of Calais who surrendered themselves to the vengeance of the English king were offering themselves as a vicarious sacrifice. They were willing to die, that their fellows might live; but this act bears no resemblance to the order of Nature above alluded to, and from which the great preacher drew his illustration. It rises to a region of which unconscious Nature knows nothing—the region of heroism. But neither fact nor set of facts contains any hint that can lead to a rational explanation of how the death of Christ benefited mankind other than in the way the death of every hero benefits us. This is an esoteric, mysterious doctrine upon which no light can be thrown by an appeal to any known fact or law of the visible universe.

The eloquent preacher tries to help out his analogy by an original conception of Sin as "a single world-spirit, exactly as electricity, with which the universe is charged, is indivisible, imponderable, one, so that you can not separate it from the great ocean of fluid. The electric spark that slumbers in the dew-drop is part of the flood which struck the oak. Had that spark not been there, it could be demonstrated that the whole previous constitution of the universe might have been different and the oak not have been struck." Every separate act of sin is the manifestation of an original principle as broad and universal as this—the world-spirit, the spirit of evil. Grant this, and still the connection can not be made. Grant that this world-spirit slew all the prophets, opposes the good in every age, and crucified "the Just One" himself, as, of course, it did and does, how did the death of Christ modify or conquer or remove this spirit, or shield man from the supposed wrath of his Creator, in any other way than the death of every just person for a worthy cause accomplishes these ends? These are mysteries that can not be explained, or the explanation even hinted at. The human faculties of reason and insight can never fathom them. Dying that others may live is truly the order of this universe, its natural order. But what examples history affords of its having been in so many instances the conscious human order—the order which makes heroes! Even in our selfish and materialistic age, as it is called, not a year passes but our pulse is quickened by the recital of some act of heroism during some disaster upon the sea or in the mines or in burning cities, wherein men have calmly faced death that others might have a chance to live. But there is no analogy here to the popular theory of the sufferings and death of Christ. All men

have to suffer the pangs of mortality just the same, and the consequences of sin just the same. When our theologians say that "Christ suffered for our sins, and that, because he suffered, our sins are forgiven," they make a statement that can not be rationally conceived; they use a language not comprehensible by human sense—the language of mysticism.

When we regard sin disinterestedly and in the light of our real knowledge, we find it but a relative term. It is not a positive thing as electricity is, but the absence of a thing, as cold is the absence of heat, or as darkness is the absence of light. It is the imperfection of human nature when tried by its highest possibilities. The theological conception of sin as imputed guilt has no more place in rational knowledge than sorcery has. The deeper our insight into the method of Nature, or the more we are impressed with the order and consistency of the world, the more incredible the popular Christianity seems to us. To the man of science the old theology is like the traditional conception of angels—men with both wings and arms.

This conception breaks with the structural plan of all vertebrates, the same as theology does with the law of cause and effect. Human beings, with wings in place of arms, might be contrary to the fact; but such a conception does not violate the homologies of Nature, but beings with both wings and arms have no counterpart in the world. They are not merely contrary to experience, they are contrary to the fundamental principle of structure that runs through the animal kingdom. But when these armed and winged beings were first conceived of, this fact was not known as it is now, and the *un*-natural element in Christianity could not have been appreciated in past ages as it is to-day.

The doctrinal part of the popular Christianity, its supernaturalism, is an inheritance from the past as much as witchcraft or magic is. But it did not break with human knowledge then; it was in strict keeping with the elements of the marvelous, and the exceptional of which human knowledge was so largely made up. There was no science in those days, no conception of the course of human or natural events as the result of immutable law. The personal point of view prevailed in everything. Everything revolved about man; superhuman beings took sides for or against him. Indeed, so far as science or a rational conception of things is concerned, the fathers of the Church, and the framers of our popular theology, were mere children. Considerations were all-powerful with them, which, to-day, would not have a feather's weight with a man of ordinary intelligence. Children readily, even eagerly, believe almost any impossible thing you may tell them about Nature. As yet they have no insight into the course of Nature, or of the law of cause and effect, no fund of experience to serve as a touchstone to the false or impossible. The same was true of the fathers, and of the races that witnessed the advent of Christianity—great in

moral and spiritual matters, but mere children so far as the development of their scientific faculties were concerned; and it is from the scientific faculties that theology, as such, proceeds. Theology is an attempt to define to the understanding the basis of man's religious convictions and aspirations; it aims to be the science of God's dealings with man and Nature, and as such it is bound to share the infirmity of the logical and scientific faculty of the times in which it arises.

The contemporaries of Jesus thought it not unreasonable that John the Baptist should come to life after his head had been cut off; that the prophet Elias should reappear upon earth, or that Jeremiah should come back. These notions were in strict keeping with the belief in the marvelous and the supernatural that then possessed men's minds. The four Gospels were a growth out of this atmosphere, and the current theology is a continuation of the same faith in prodigies as opposed to natural occurrences. The fathers knew little more about the true order of the physical universe than savages. They believed, for instance, the use of the spade made the earth fertile because it was of the form of a cross; that the sun, moon, and stars shone less brightly since the fall. Irenæus gave, as his reasons for accepting the four Gospels and no more, the fact that there are four universal winds and four quarters of the earth, and because living creatures are quadriform. Origen believed that the sun, moon, and stars were living, rational beings, capable of sinning, and are subject to vanity, etc., and that they pray to the Supreme Being through his only-begotten Son. Tertullian shared the belief of his contemporaries that the hyena changes its sex every year, being alternately male and female. Clement, of Rome, believed the story of the phœnix, that wonderful bird of Arabia, which was said to live five hundred years; and when it died at the end of that time, that a worm sprang from its decaying flesh which soon became a new phœnix, which forthwith took up the bones of its defunct parent and flew away to the city of Heliopolis, in Egypt, and laid them on the altar of the sun. The natural philosopher has always taught that "death is a law and not a punishment," but "the fathers taught it is a penal infliction introduced into the world on account of the sin of Adam, which was also the cause of the appearance of all noxious plants, of all convulsions in the material globe, and, as was sometimes asserted, even of a diminution of the light of the sun." How dormant and puerile man's scientific faculties were during the early centuries of Christianity, when the foundations of the science of theology were laid, is well illustrated in a work called the "Christian Opinion concerning the World," by the monk Cosmas, of the sixth century. Cosmas taught that the earth was literally a tabernacle, because St. Paul speaks of it as such, and that Moses exactly copied its form in his tabernacle. It is a flat parallelogram, twice as long as it is broad, roofed in by the sky, which is *glued* to the outer edges of the earth. It consists of two stories, in one of which dwell the blessed, and in the other

the angels, etc. It is from the type of mind that conceived such notions of the universe as this that we inherit our theology. But it may be replied, men may be feeble in science but great in religion. True, the fathers, many of them, were great in religion, they were great on the moral and spiritual side; but the system of theology they founded aims to be a science; it deals with exact propositions; it is not the work of their subjective religious natures but of their scientific faculties, and as such it is just as artificial, just as puerile and unreal, as the notions of the physical universe to which I have adverted.

The whole Christian dispensation, as expounded by the popular theology, is as little in keeping with the physical order of the world as disclosed by science, or with the natural moral order as disclosed by the conscience, as Indian medicine is in keeping with modern pathology. The whole scheme hinges upon the fall of Adam in paradise as an historical event, an act of disobedience on the part of the original progenitor of the human family, in consequence of which sin and death entered the world, and the suffering and death of Jesus became necessary to bring about a reconciliation between an angry God and rebellious man, etc.; with the attendant doctrine of the mystery of the atonement, of salvation by grace, of the eternal punishment of the pre-Christian nations, etc. Now this conception as science, or as a rational explanation of the world as it is, and of man's salvation, is on a par with Cosmas's theory of the earth with the sky glued to the outer edges. It shows the working of the same type of mind, it rests upon the same arbitrary and artificial view of things.

But, in all these matters, the question now is whether the ancient or the modern point of view shall prevail; whether evolution, or revelation, is the law of the world. The ancient point of view, as we have seen, was exclusive and arbitrary; it looked upon the universe as something *made* and governed by a being or beings external to it. In medicine, it regarded all disease as the work of evil spirits, that were to be exorcised by charms or amulets or incantations. In politics, it inculcated the divine right of kings, that the king can do no wrong, etc. In political economy, it taught that the interests of nations were mutually antagonistic and destructive of one another. In physical science, it encouraged the notions we have seen. The fathers taught that all men were under condemnation from the moment of their birth, and that at death the souls of unbaptized infants went straight to hell. St. Augustine taught, and the Catholic Church still holds, that when water from the hands of a priest falls upon the head of an unconscious infant, a miraculous change is wrought in its spiritual nature—a change by which it becomes essentially a new and a higher being; and the Church says, with characteristic charity, of him who believes not this impossible doctrine, "Let him be accursed!"

It is this type of mind which fostered alchemy, astrology, sorcery, witchcraft, and demonology. The air and the earth and the waters

swarmed with spirits, good and evil; disease, pestilence, storms, and fires and floods were the work of evil spirits; the more kindly motions of Nature were the work of good spirits. A decrepit old woman could turn herself into a wolf and devour her neighbor's flocks. Meteors, eclipses, and comets were portents sent directly from Heaven for the warning of mankind.

How has all this been changed! How completely the mind of man now faces the other away, in everything except in theology—faces toward a natural explanation of all phenomena!

Let no hasty reader conclude that I am arguing against the reality of religion; I am only arguing against the reality of magic and miracles; against the conception of Christianity as a scheme for man's salvation *interpolated* into human history, and in no sense one with the constitution of the world; against the idea that the spiritual life is in no sense a possible development of man's natural capabilities; but something superadded from without, a unique and peculiar kind of life, which was made possible to man by the life and death of Christ, and in no way possible before that event. It is not an evolution from man's proper nature; it comes from the opposite direction, and is external and supplementary. "Christianity," say the Andover doctors, "is a source of knowledge concerning God which is not given by the external universe nor by the constitution of man, but only by Christ." Religion is still conceived of as a miraculous scheme to remedy some miscarriage or failure in the plan of God's dealings with man, a failure whereby his relation to the race was radically changed. It is looked upon as something naturally foreign to man, something to be ingrafted upon him from without, not related at all to his natural capacity for virtue and goodness; something which a blameless man may live and die without, but which a cut-throat during the last moments of his life upon the scaffold may, by what is called an act of faith and repentance, obtain! Against such notions I am directing my argument; I am urging that the sentiment of religion is the same in all ages and lands, differing in its outward forms, but not in its inward essence, just as the sentiment of patriotism or of loyalty is the same. How is a reasonable man to favor any scheme that rules out the religion of Plato, and Zeno, and Seneca, and Epictetus, and Cicero, and Lucretius, or Spinoza, or of Darwin, as of no avail, as only snares of Satan? The flowering of man's spiritual nature is as natural and as strict a process of evolution as the opening of a rose or a morning-glory. The vital inflorescent forces are from within, and are continuous from the root up. But there is this difference: While the plant must have a congenial environment, light, warmth, etc., the human flowering often takes place amid the most adverse surroundings; but no more so in the religious sphere than in the intellectual.

Neither would I say that the "conversion" upon which our Puritan ancestors laid such stress, and which is so dramatically illustrated in

the case of Paul, was not genuine. It was genuine to them, but it was entirely a subjective phenomenon, like the faith-cures we now often hear about; it was the power of the imagination working upon the conscience. It is not a necessary or universal experience, even among religious people. It may be said without any irreverence that it has gone out of fashion. The predisposition for that kind of experience no longer exists. "The belief in witchcraft," says Milman, "made people fancy themselves witches," and the belief in the efficacy of sudden conversions led to these sorts of moral and spiritual earthquakes.

Science looks upon religion as belonging to the sphere of the natural; it is the legitimate outcome of man's moral nature; the term that best expresses the complete development and flowering of all his faculties. To define it in the guarded terms which Principal Tulloch uses, namely, as "an inner power of Divine mystery awakening the conscience," is to make it something external to man and more or less arbitrary and theological. This view the world has long clung to, but it must go—is going. The Biblical writers had no theology; the Bible is strictly a religious book, and in no sense a theological treatise. Paul developed or outlined some theological notions; but wherein was Paul great—in his theology, or in his religious fervor; in his notions of predestination, or in his aspirations after righteousness? Jesus is as free from any theological bias as a child is from metaphysics. He taught but one thing, namely, that the kingdom of heaven is in the condition of the heart, a condition illustrated by his own life. The vast and elaborate system of theology which grew up out of his parables and his Orientalism, and overshadowed the world for fifteen hundred years or more, and begat some of the darkest crimes the history of man has to show, is as far from his spirit and that of his disciples as the east is from the west.

Undoubtedly, religion knows certain things in a more intimate and personal way than science does; so does poetry, so does literature; and science can understand how this is so. What we receive through the emotions is more vital and personal to us than what reaches us through the reason. The person in whose mind has been awakened a deep love of Christ, comes to know Christ in a way the mere outside observer does not; his spirit takes hold of the Christ-idea, and is filled and modified by it to an extent the other is not. An emotional process is more potent than a rational process. The knowledge thus gained is no more truly knowledge, but it is more vital knowledge. It is not merely conviction; it is attraction and affiliation as well. But this is true not of Christ merely; it is true of the whole range of our experience. If the flower, or the bird, or the rock awaken no emotion in the observer, will he ever come truly to know it? Unless we love an author, can we ever get at his deepest and most precious meaning? Hence Goethe said, "We learn to know nothing but what we love."

In this light, science sees that the love of Christ, or of God, may transform a man's life, but not by any peculiar and supernatural process, but by a universal and well-known law, namely, that we grow like that which we love. Every object we look upon or think of with the emotion of love, that object in a measure we become. But, to begin with, we are not capable of loving it until we are in some degree, either potentially or actually, like it. No radically un-Christlike nature will ever come to love Christ. Hence the subtile truth in the old doctrines that have been so hardly and literally stated, "Except God work in you to will and to do," etc. The Christian, the virtuous, pious soul, is born, and not made, just as truly as is the poet or artist, and the "new birth," in the one case, can mean no more than it does in the other. The true Christian only gives a new name to his natural piety or aptitude for Christianity, but in no sense is there a radical change of nature. It is simply a transference of allegiance, as in the case of Paul. All these things may be so stated as to harmonize with the rest of our knowledge, but as expounded in theological books they do not so harmonize, but run counter to it completely. Subjective truths are stated as if they were objective *facts;* qualities of the mind and spirit are expounded as if they were realities of the experience.

Certain of the alleged miracles of the New Testament, as the healing of the sick by an act of faith, agree with what we now know to be true. Certain human ailments, mainly diseases of the mind and the nervous system, have in recent times undoubtedly yielded to an act of faith in the supreme efficacy of certain rites, or to an unwonted mental resolution. But the remedy is subjective and not objective. The virtue was not in the hem of the garment touched, but in the effort of the will of the person who touched it.

What is at variance with the rest of our knowledge in the New Testament are such things as grew up naturally in a superstitious age around the person and teachings of such a transcendent being as Jesus was—the notion that he was more than human, that he had no earthly father, that he had some superhuman control over the forces of Nature, that he rose from the dead, that his death bore some mysterious relation to the sins of the world, etc. When a man talks about the value and importance of the ethics of Christianity—of charity, of mercy, of justice, of gentleness, of purity, or righteousness, or of what the world has in all ages taught to be highest and best—we can understand him; he speaks the language of truth and soberness. When he says, with Marcus Aurelius, that there is but one thing of real value—"to cultivate truth and justice, and live without anger in the midst of lying and unjust men"; or when he says with Peregrinus that "the wise man will not sin, though both gods and men should overlook the deed; for it is not through the fear of punishment or of shame that he abstains from sin: it is from the desire and obligation of what is just

and good"; or when he says with Micah, "And what doth the Lord require of thee but to do justly and to love mercy, and to walk humbly with thy God?" or when he says with Solomon that "the fear of the Lord is to hate evil"; or with Jeremiah, "He judged the cause of the poor and needy—was not this to know me? saith the Lord"; or when he says with St. James, "Pure religion and undefiled before God and the Father is this, to visit the fatherless and widows in their affliction, and to keep himself unspotted from the world," he gives utterance to sentiments that appeal to the best there is in every man, and that agree with the highest wisdom of all ages and races. Science can understand it and verify it.

But when he talks to us about Jesus in the language of the evangelical churches—about the atonement, original sin, sanctification, saving grace, etc.—he simply uses a jargon that may mean something to him, but can mean nothing at all to an outsider. He states things as facts which have no ground either in reason or experience; they belong to a world apart, which neither the rest of our knowledge nor our natural faculties of reason and observation can put us in communication with. He might just as well talk about the elixir of life or of the philosopher's stone. The traditional theology has undoubtedly proved itself a good working hypothesis with crude and half-developed minds, but upon what thoughtful and cultivated person does it now make an impression? No race has been lifted out of barbarism without the aid of supernatural machinery. Once lifted out, how prone we are to discredit the machinery! We have no further use for it. We have outgrown it. But the mass of mankind are slow to outgrow it. To the mass of mankind the miraculous element of Christianity still seems vital and of first importance. Discredit that, and you have discredited religion itself in their eyes. But not so with the philosopher, or with the man who is bent on seeing and knowing things exactly as they are.

I think it is in accordance with the rest of our knowledge that Christianity could not have made its way in the world, its superior ethical and moral system could not have gained the ascendency, without the cloud of myths in which they came enveloped. What a seal of authentication is put upon it by the myth of the resurrection of Jesus! How this fact stuns and overwhelms the ordinary mind! Was it Talleyrand who replied to some enthusiast who proposed to start a new religion, that he advised him to begin by getting himself crucified, and to rise again on the third day? As a new cult founded upon reason alone, or as a natural religion alone, Christianity could not have coped with the supernatural religions that then possessed the world. Men's minds were not prepared for it, and it is probably equally true that the mass of mankind are not yet prepared for a religion based upon natural knowledge alone. But the time is surely coming, and natural science is to be the chief instrument in bringing it about. The religious sense of man is less and less dependent upon

thaumaturgical aids. It is beginning to hear God in the still small voice; not in the tempest, or in the earthquake, or the fire; not in the marvelous, the extraordinary, the irrational, but in the quiet and familiar facts of Nature and of life. The vulgar mind asks for a sign, a wonder; but science has no sign, no wonder to show. It points to the simplest fact. Its relation toward the old theology is like that of Elisha toward Naaman. When Naaman came to the prophet to be cured of his leprosy, he expected Elisha to do some wonderful thing, some miracle. "Behold, I thought, He will surely come out to me, and stand, and call on the name of the Lord his God, and strike his hand over the place, and recover the leper." Instead of which the prophet simply told him to go and wash seven times in the Jordan and be clean. "My father," said his servant to the indignant Naaman, "if the prophet had bid thee do some great thing, wouldest thou not have done it? how much rather then, when he saith to thee, Wash, and be clean?"

The leprosy of the miraculous which taints men's minds is to be got rid of in the same way: wash and be clean in the current of the sweet-flowing Nature that is always near at hand, and that is always and everywhere the same.

PRESENT STATUS OF THE GREEK QUESTION.

By EDMUND J. JAMES,
PROFESSOR OF PUBLIC FINANCE AND ADMINISTRATION IN THE UNIVERSITY OF PENNSYLVANIA.

THE recent action of the Harvard College authorities, in striking Greek from the list of studies required for the degree of A. B. marks an era in the history of college education in this country. The long struggle, which has been carried on at times with much bitterness between the classical and modern party, has been distinctly advanced one stage toward a final settlement. The adherents of the classical course have strenuously claimed for it a marked superiority over all others, and have uniformly resisted any attempt to change or supplant it. The friends of the new studies have as vigorously contended that it is perfectly possible to construct a curriculum which, while omitting some of the specific subjects before included and substituting others for them, should still as fully deserve the name liberal as the old course.

The struggle has assumed different forms at different times. At one period it was simply an attempt on the part of those who thought modern subjects worthy of recognition beside the antiquities to secure for them some place in the college curriculum. This demand, modest as it was, was resisted with the same obstinacy as that which has characterized the opposition to later and far more sweeping demands. It was a great day for American education when modern subjects, such as the natural and physical sciences, history, English and other modern

languages, and social science, were finally admitted to a place in the curriculum of the colleges. It was insisted, however, that space should be found for them, not by cutting the time given to Greek and Latin, but simply by demanding more in these subjects for admission, and thus giving to them as much time as was given before and lengthening the college course correspondingly, so that a college boy is now much older than he was a half-century ago. When further demands were made with irresistible force, they were finally met by a reluctant permission to establish so-called modern or Latin-scientific or scientific courses, parallel with the old, but carrying with them a separate degree which did not recognize the candidate as a liberally educated man, whatever else he might be. It was thus that the field lay, when Dr. Eliot began fifteen years ago his career as President of Harvard College. An earnest agitation was shortly begun to make Greek elective in the course for the degree of A. B. It was maintained that the facilities for study and methods of teaching, etc., in the modern studies had been so far perfected that they could put something else in the place of Greek and still fairly claim for the man who had completed the course the proud title of bachelor of liberal arts.

Here the adherents of the old system made a desperate stand and were determined to fight the proposal to the bitter end. How far President Eliot may be personally responsible for the view within Harvard College which admitted the reasonableness of this claim of the "modernists" I am not aware. But certain it is that, whether rightly or wrongly, he is identified with it in the public mind. With every passing year, with every extension in the courses of study at Harvard, with every improvement in their facilities for giving instruction in these new branches, with every debate on the question in the faculty meetings, with every careful and unprejudiced consideration of the question in a broad or liberal way, with every increase in pedagogical knowledge; and with every comparison of our own system with that of progressive nations abroad and the tendencies of thought on educational matters elsewhere, the number of those favorable to the scheme increased, until during the last year the plan was finally adopted which marked the culmination of the long development. So fully was it recognized that Harvard's decision on the matter, if favorable to the claims of the modern party, would lend an inmense impetus to the cause everywhere and ultimately lead to the utter rout of the "ancients," that a very unusual step was taken by several of the New England college presidents. Eight of them joined in a circular memorial to the Board of Overseers of Harvard College in the spring of 1885, praying that no relaxation be made in the requisition of Greek for the A. B. I think I am right in saying that such action was unprecedented in the history of American education—the head of eight institutions of learning uniting in a request to the governing board of a ninth institution that it should not comply with the request of its

faculty in regard to the course of study. It only serves to show how overwhelming the arguments in favor of such a course must have been when the prayer of such a distinguished body of clergymen as that whose names were appended to this document should have produced no visible effect whatever, except to lend additional force to the victory of the aggressive party.

The great and imperishable service which Harvard College has rendered to American education in the last fifteen years consists in two things. It has extended enormously the range of subjects in which instruction is offered within it own limits, and thereby made it absolutely necessary for all other institutions which did not wish to lag hopelessly in the rear to do the same. This necessity has produced unusual efforts in every one of these old institutions to extend its facilities. One is perfectly safe in saying that the students of every other American college of high rank owe it to-day very largely to the example of Harvard that they have in their own college far better opportunities for study than their predecessors of fifteen years ago. And the boys of to-day may largely thank Harvard for taking such a position as has resulted in bringing to them advantages which otherwise might have come only to their children.

The other service is one of equal if not of greater value, viz., the full recognition of the equivalency of different lines of study from a liberal point of view, thus practically giving force to a conviction which almost always forces itself upon one as the result of any extended study of the art and science of education. This recognition has been given in two different forms, though at bottom they are parts of one and the same general plan. It has been given by the general introduction of the elective-study system within the college itself, thus recognizing the equivalency from a liberal point of view of all lines of study, at least after the student had learned a minimum amount of Latin, Greek and mathematics, and modern languages and science. It has now gone still further, and recognizes the full equivalency of different lines of preparatory study before the student comes to the college itself. Every one who has taken the requirements for admission and studied them carefully, is surprised to learn how many different combinations may be made, all of which are recognized as equally fitting a boy to take a liberal course of study. The difference between the new list and the old is very great, and may be properly denominated as epoch-making. The most important feature, and the one which interests us most in this immediate connection, is the fact that it is now possible to make up a combination which will be accepted as satisfying all requirements but which shall contain no Greek.

I am not trying to prove that this last-mentioned feature is a good thing, though it is my personal opinion that it is good. I wish merely to call attention to the fact that Greek is finally ousted from the place which it has hitherto held in the curriculum of the oldest and most

extensive center of learning on this continent, as a required subject of study.

Harvard, however, was not the first of our institutions of high rank to discard Greek from the list of its requirements for the degree of A. B. Johns Hopkins University led the way in this revolution, as in so many other good things. But its lead in the matter, owing to several circumstances, did not have anything like the same influence which Harvard's will have. In the first place, the institution had no history prior to 1876, and it was a matter which attracted but little atention when it opened, that in this regard it began at a point to which no other American institution had at that time come. It was, moreover, organized on quite a different plan from the ordinary college, and the work at first seemed to outsiders to be chiefly of post-graduate character, in which this question played but an unimportant part. Harvard, on the contrary, still retains its college form, though the spirit of the college, in the traditional sense, at least, has long since departed. Any action taken by it seems, therefore, much nearer to the average college than that of such an institution as the university at Baltimore.

Johns Hopkins allows the substitution of modern languages for Greek in the course for the degree of A. B.—i. e., it has from the first recognized the equivalency of different lines of work for the degree which crowns the course of liberal arts. The two institutions in America which, taken all in all, each in its own way, stand at the head of our educational system, join, then, in this revolutionary step. How long can the other institutions hold out along the old lines? The fortress which the defenders of the old system have recognized as the key to the situation has fallen, it is a mere question of time how soon the others must capitulate; and we may be sure that, when they do, it will be without conditions.

If we take a glance at conditions in foreign countries, we can better understand how thoroughly in sympathy with the general progress of education in our modern world this new step is, and consequently how exceedingly sure it is of never being retraced. It is safe to say, after making all due allowances for many acknowledged defects, that the higher institutions of Germany stand as a whole at the head of similar institutions in the world. Certain it is that German educational literature leads the world. It is also certain that the educational ideals of young men in this country have been powerfully influenced by contact with German institutions. It will also be agreed that the Germans can not be accused of headlong radicalism in educational or other matters. It is worth our while, then, to notice what they are doing in this direction.

When we examine the requirements for the degree of Master of Arts, which is the German degree which corresponds most closely with our A. B., we find that not a single one of the German universities require any knowledge of Greek whatever for this degree. It is now sixteen

years since the requirement of Greek for this degree and that of Ph. D. (with which the A. M. is always given) was dropped in Prussia; and although some of the German professors would like to see Greek restored to its place in the list of requirements, because it would reduce the number of students at the universities, and some others would like to see it restored for the same reasons which affect the opinion of some American educators, there is no more probability of its being restored than there is that the study of Hebrew or Sanskrit will be made compulsory.

It is a very significant fact, indeed, that the deepest students of the art and science of education in Germany are opposed to the requirement of Greek. A recent work by Professor Paulsen, of the University of Berlin, on the history of university education in Germany since the close of the middle ages, has some exceedingly significant remarks on this topic. He shows in a masterly way how prevailing ideas change in regard to the value of Greek and the proper method of its study from decade to decade. He pictures also how this language has been slowly slipping away from the position which it held fifty years ago, and how surely one can draw the conclusion as to its ultimate fate. He assigns to it, indeed, a much more subordinate place than any one here demands. He says that the course of development points to the irresistible conclusion that Greek must disappear altogether from the list of studies common in the preparatory course—must become like Sanskrit, Hebrew, Arabic, etc., a language to be studied by but few persons—chiefly those who expect to make a profession of preaching or teaching language. He recognizes certain difficulties in the way of the speedy realization of this end, most of which are not pedagogical at all, but social and political—i. e., difficulties which are entirely extraneous to the merits of the case.

The amount of Greek still required for the simple A. B. or M. A. at English or Scotch universities is ridiculously small when judged in the light of the wonderful results in the way of liberal education which are claimed for them, and there can be but little doubt that just as soon as the modern party can make itself felt and pedagogical considerations secure the weight which is now accorded only to social and political prejudice, the requirement of Greek in these pass-examinations will go the way that many other old regulations of the university have gone, which were vigorously defended by lovers of the old when they were attacked, and which would now find absolutely no apologist.

Of course, all this is independent of the merits of the question, and I have proposed simply to describe actual facts in regard to present conditions, and to call attention to what seems to be the inevitable drift of events. Very few who belong to the so-called modern party desire to belittle the study of Greek properly pursued, or would think of classing Greek in the same list as Sanskrit relative to its importance to our culture or civilization. They simply recognize the fact that

life is short, and that there are many different types of intellectual ability calling for many different combinations of studies. The number of subjects of study has become so enormously large, and the value of our own literature has increased to such an extent since the time when Greek was incorporated into our school curricula, that it is now utterly idle to think of requiring Greek of all students to whom we will accord the distinction, so far as college degrees will do it, of being liberally educated.

It will not do to say that we can have a separate degree for those who have not studied Greek. The subject is no longer important enough in comparison with other studies to deserve a separate degree; and, as long as we make this distinction, we shall practically close the doors of many of our institutions to numbers of students who would otherwise be found in our academic halls. It may be said that the degree of A. B. will have no recognized value such as it has at present. It is a stretch of language to say that the degree of A. B. has in this country a recognized value in the sense in which that expression is used in this connection. Institutions of all kinds can give the degree at pleasure, and some give it to men who could not enter the freshman class at Harvard College. At any rate, it would mean something in the same sense as the German Ph. D., which is one of the most honorable of degrees, and has lost neither in dignity, or value since Greek was dropped from the list of studies required for it.

Whatever we may think of the movement, whether we favor or oppose it, it seems perfectly clear that it is bound to go forward; and, as in the case of all other great changes, those who oppose it so valiantly at present may never be converted—that is too much to expect of those whose careers are identified with the old *régime*—but they will be overruled; or, when they retire, their places will be filled with men who will wonder how their predecessors could ever have held such opinions.

THE SUN'S HEAT.*

By Sir WILLIAM THOMSON, F. R. S.

FROM human history we know that for several thousand years the sun has been giving heat and light to the earth as at present; possibly with some considerable fluctuations, and possibly with some not very small progressive variation. The records of agriculture, and the natural history of plants and animals within the time of human history, abound with evidence that there has been no exceedingly great change in the intensity of the sun's heat and light within the last three

* Lecture on "The Probable Origin, the Total Amount, and the Possible Duration, of the Sun's Heat," delivered by Sir William Thomson, F. R. S., at the Royal Institution, on Friday, January 21, 1887.

thousand years; but for all that there may have been variations of quite as much as five or ten per cent, as we may judge from considering that the intensity of the solar radiation to the earth is six and a half per cent greater in January than in July; and neither at the equator nor in the northern or southern hemispheres has this difference been discovered by experience or general observation of any kind. But as for the mere age of the sun, irrespective of the question of uniformity, we have proof of something vastly more than three thousand years in geological history, with its irrefragable evidence of continuity of life on the earth in time past for tens of thousands, and probably for millions of years.

Here, then, we have a splendid subject for contemplation and research in natural philosophy, or physics, the science of dead matter. The sun, a mere piece of matter of the moderate dimensions which we know it to have, bounded all round by cold ether, has been doing work at the rate of four hundred and seventy-six thousand million million million horse-power for three thousand years and at possibly more, and certainly not much less, than that for a few million years. How is this to be explained? Natural philosophy can not evade the question, and no physicist who is not engaged in trying to answer it can have any other justification than that his whole working time is occupied with work on some other subject or subjects of his province by which he has more hope of being able to advance science.

I suppose I may assume that every person present knows as an established result of scientific inquiry that the sun is not a burning fire, and is merely a fluid mass cooling, with some little accession of fresh energy by meteors occasionally falling in, of very small account in comparison with the whole energy of heat which he gives out from year to year. You are also perfectly familiar with Helmholtz's form of the meteoric theory, and accept it as having the highest degree of scientific probability that can be assigned to any assumption regarding actions of prehistoric times. You understand, then, that the essential principle of the explanation is this: at some period of time, long past, the sun's initial heat was generated by the collision of pieces of matter gravitationally attracted together from distant space to build up his present mass; and shrinkage due to cooling gives, through the work done by the mutual gravitation of all parts of the shrinking mass, the vast thermal capacity in virtue of which the cooling has been, and continues to be, so slow. I assume that you have not been misled by any of your teachers who may have told you, or by any of your books in which you may have read, that the sun is becoming hotter because a gaseous mass, shrinking because it is becoming colder, becomes hotter because it shrinks.

An essential detail of Helmholtz's theory of solar heat is that the sun must be fluid, because even though given at any moment hot enough from the surface to any depth, however great, inward, to be

brilliantly incandescent, the conduction of heat from within through solid matter of even the highest conducting quality known to us would not suffice to maintain the incandescence of the surface for more than a few hours, after which all would be darkness. Observation confirms this conclusion so far as the outward appearance of the sun is concerned, but does not suffice to disprove the idea which prevailed till thirty or forty years ago that the sun is a solid nucleus inclosed in a sheet of violently agitated flame. In reality the matter of the outer shell of the sun, from which the heat is radiated outward, must in cooling become denser, and so becoming unstable in its high position, must fall down, and hotter fluid from within must rush up to take its place. The tremendous currents thus continually produced in this great mass of flaming fluid constitute the province of the newly developed science of solar physics, which with its marvelous instrument of research—the spectroscope—is yearly and daily giving us more and more knowledge of the actual motions of the different ingredients, and of the splendid and all-important resulting phenomena.

Now, to form some idea of the amount of the heat which is being continually carried up to the sun's surface and radiated out into space, and of the dynamical relations between it and the solar gravitation, let us first divide that prodigious number (476×10^{21}) of horse-power by the number ($6{\cdot}1\times10^{18}$) of square metres in the sun's surface, and we find 78,000 horse-power as the mechanical value of the radiation per square metre. Imagine, then, the engines of eight ironclads applied to do all their available work of, say, 10,000 horse-power each, in perpetuity driving one small paddle in a fluid contained in a square metre vat. The same heat will be given out from the square metre surface of the fluid as is given out from every square metre of the sun's surface.

But now to pass from a practically impossible combination of engines and a physically impossible paddle and fluid and containing vessel, toward a more practical combination of matter for producing the same effect: still keep the ideal vat and paddle and fluid, but place the vat on the surface of a cool, solid, homogeneous globe of the same size ($\cdot697\times10^9$ metres radius) as the sun, and of density (1·4) equal to the sun's density. Instead of using steam-power, let the paddle be driven by a weight descending in a pit excavated below the vat. As the simplest possible mechanism, take a long vertical shaft, with the paddle mounted on the top of it so as to turn horizontally. Let the weight be a nut working on a screw-thread on the vertical shaft, with guides to prevent the nut from turning—the screw and the guides being all absolutely frictionless. Let the pit be a metre square at its upper end, and let it be excavated quite down to the sun's center, everywhere of square horizontal section, and tapering uniformly to a point at the center. Let the weight be simply the excavated matter of the sun's mass, with merely a little clearance space between it and

the four sides of the pit, and a kilometre or so cut off the lower pointed end to allow space for its descent. The mass of this weight is 326×10^6 tons. Its heaviness, three quarters of the heaviness of an equal mass at the sun's surface, is 244×10^6 tons solar surface-heaviness. Now a horse-power is 270 metre-tons, terrestrial surface heaviness, per hour; or ten metre-tons, solar surface-heaviness, per hour. To do 78,000 horse-power, or 780,000 metre-tons, solar surface-heaviness, per hour, our weight must therefore descend at the rate of one metre in 313 hours, or about twenty-eight metres per year.

To advance another step, still through impracticable mechanism, toward the practical method by which the sun's heat is produced, let the thread of the screw be of uniformly decreasing steepness from the surface downward, so that the velocity of the weight, as it is allowed to descend by the turning of the screw, shall be in simple proportion to distance from the sun's center. This will involve a uniform condensation of the material of the weight; but a condensation so exceedingly small in the course even of tens of thousands of years, that, whatever be the supposed character, metal or stone, of the weight, the elastic reaction against the condensation will be utterly imperceptible in comparison with the gravitational forces with which we are concerned. The work done per metre of descent of the top end of the weight will be just four fifths of what it was when the thread of the screw was uniform. Thus, to do the 78,000 horse-power of work, the top end of the weight must descend at the rate of thirty-five metres per year: or seventy kilometres, which is one one hundredth per cent ($\frac{1}{10000}$) of the sun's radius, per two thousand years.

Now let the whole surface of our cool solid sun be divided into squares, for example, as nearly as may be, of one square metre area each, and let the whole mass of the sun be divided into long, inverted pyramids or pointed rods, each 700,000 kilometres long, with their points meeting at the center. Let each be mounted on a screw, as already described for the long tapering weight which we first considered; and let the paddle at the top end of each screw-shaft revolve in a fluid, not now confined to a vat, but covering the whole surface of the sun to a depth of a few metres or kilometres. Arrange the viscosity of the fluid and the size of each paddle so as to let the paddle turn just so fast as to allow the top end of each pointed rod to descend at the rate of thirty-five metres per year. The whole fluid will, by the work which the paddles do in it, be made incandescent, and it will give out heat and light to just about the same amount as is actually done by the sun. If the fluid be a few thousand kilometres deep over the paddles, it would be impossible, by any of the appliances of solar physics, to see the difference between our model mechanical sun and the true sun.

Now, to do away with the last vestige of impracticable mechanism, in which the heavinesses of all parts of each long rod are supported

on the thread of an ideal screw cut on a vertical shaft of ideal matter, absolutely hard and absolutely frictionless: first, go back a step to our supposition of just one such rod and screw working in a single pit excavated down to the center of the sun, and let us suppose all the rest of the sun's mass to be rigid and absolutely impervious to heat. Warm up the matter of the pyramidal rod to such a temperature that its material melts and experiences enough of Sir Humphry Davy's "repulsive motion" to keep it balanced as a fluid, without either sinking or rising from the position in which it was held by the thread of the screw. When the matter is thus held up without the screw, take away the screw or let it melt in its place. We should thus have a pit from the sun's surface to his center, of a square metre area at the surface, full of incandescent fluid, which we may suppose to be of the actual ingredients of the solar substance. This fluid, having at the first instant the temperature with which the paddle left it, would at the first instant continue radiating heat just as it did when the paddle was kept moving; but it would quickly become much cooler at its surface, and to a distance of a few metres down. Convection-currents, with their irregular whirls, would carry the cool fluid down from the surface, and bring up hotter fluid from below, but this mixing could not go on through a depth of very many metres to a sufficient degree to keep up anything approaching to the high temperature maintained by the paddle; and after a few hours or days, solidification would commence at the surface. If the solidified matter floats on the fluid at the same temperature below it, the crust would simply thicken as ice on a lake thickens in frosty weather; but if, as is more probable, solid matter, of such ingredients as the sun is composed of, sinks in the liquid when both are at the melting temperature of the substance, thin films of the upper crust would fall in, and continue falling in, until, for several metres downward, the whole mass of mixed solid and fluid becomes stiff enough (like the stiffness of paste or of mortar) to prevent the frozen film from falling down from the surface. The surface film would then quickly thicken, and in the course of a few hours or days become less than red-hot on its upper surface. The whole pit full of fluid would go on cooling with extreme slowness until, after possibly about a million million million years or so, it would be all at the same temperature as the space to which its upper end radiates.

Now, let precisely what we have been considering be done for every one of our pyramidal rods, with, however, in the first place, thin partitions of matter impervious to heat separating every pit from its four surrounding neighbors. Precisely the same series of events as we have been considering will take place in every one of the pits.

Suppose the whole complex mass to be rotating at the rate of once round in twenty-five days.

Now at the instant when the paddle stops let all the partitions be

annulled, so that there shall be perfect freedom for convection-currents to flow unresisted in any direction, except so far as resisted by the viscosity of the fluid, and leave the piece of matter, which we may now call the sun, to himself. He will immediately begin showing all the phenomena known in solar physics. Of course, the observer might have to wait a few years for sun-spots, and a few quarter-centuries to discover periods of sun-spots, but they would, I think I may say, probably, all be there just as they are: because I think we may feel that it is most probable that all these actions are due to the sun's own mass and not to external influences of any kind. It is, however, quite possible, and indeed many who know most of the subject think it probable, that some of the chief phenomena due to sun-spots arise from influxes of meteoric matter circling round the sun. The energy of chemical combination is as nothing compared with the gravitational energy of shrinkage, to which the sun's activity is almost wholly due, but chemical combinations and dissociations may, as urged by Lockyer, be thoroughly potent determining influences on some of the features of non-uniformity of the brightness in the grand phenomena of sun-spots, hydrogen-flames, and corona, which make the province of solar physics. But these are questions belonging to a very splendid branch of solar science with which we are not occupied this evening.

What concerns us at present may be summarized in two propositions:

1. Gigantic convection-currents throughout the sun's liquid mass are continually maintained by fluid, slightly cooled by radiation, falling down from the surface, and hotter fluid rushing up to take its place.

2. The work done in any time by the mutual gravitation of all the parts of the fluid, as it shrinks in virtue of the lowering of its temperature, is but little less than (so little less than, that we may regard it as practically equal to*) the dynamical equivalent of the heat that is radiated from the sun in the same time.

The rate of shrinkage corresponding to the present rate of solar radiation has been proved to us, by the consideration of our dynamical model, to be thirty-five metres on the radius per year, or one ten-thousandth of its own length on the radius per two thousand years. Hence, if the solar radiation has been about the same as at present for two hundred thousand years, his radius must have been greater by one per cent two hundred thousand years ago than at present. If we wish to carry our calculations much farther back or forward than two hundred thousand years, we must reckon by differences of the reciprocal of the sun's radius, and not by differences simply of the radius, to take into account the change of density (which, for example, would be three per

* "On the Age of the Sun's Heat," by Sir William Thomson ("Macmillan's Magazine, March, 1862); and Thomson and Tait's "Natural Philosophy," second edition, vol. i, part ii, Appendix E.

cent for one per cent change of the radius). Thus the rule, easily worked out according to the principles illustrated by our mechanical model, is this:

Equal differences of the reciprocal of the radius correspond to equal quantities of heat radiated away from million of years to million of years.

Take two examples:

1. If in past time there has been as much as fifteen million times the heat radiated from the sun as is at present radiated out in one year, the solar radius must have been four times as great as at present.

2. If the sun's effective thermal capacity can be maintained by shrinkage till twenty million times the present year's amount of heat is radiated away, the sun's radius must be half what it is now. But it is to be remarked that the density which this would imply, being 11·2 times the density of water, or just about the density of lead, is probably too great to allow the free shrinkage as of a cooling gas to be still continued without obstruction through overcrowding of the molecules. It seems, therefore, most probable that we can not for the future reckon on more of solar radiation than, if so much as, twenty million times the amount at present radiated out in a year. It is also to be remarked that the greatly diminished radiating surface, at a much lower temperature, would give out annually much less heat than the sun in his present condition gives. The same considerations led Newcomb to the conclusion that "it is hardly likely that the sun can continue to give sufficient heat to support life on the earth (such life as we now are acquainted with, at least) for ten million years from the present time."

In all our calculations hitherto we have for simplicity taken the density as uniform throughout, and equal to the true mean density of the sun, being about 1·4 time the density of water, or about a fourth of the earth's mean density. In reality the density in the upper parts of the sun's mass must be something less than this, and something considerably more than this in the central parts, because of the pressure in the interior increasing to something enormously great at the center. If we knew the distribution of interior density, we could easily modify our calculations accordingly; but it does not seem probable that the correction could, with any probable assumption as to the greatness of the density throughout a considerable proportion of the sun's interior, add more than a few million years to the past of solar heat, and what could be added to the past must be taken from the future.

In our calculations we have taken Pouillet's number for the total activity of solar radiation, which practically agrees with Herschel's. Forbes* showed the necessity for correcting the mode of allowing for atmospheric absorption used by his two predecessors in estimating the total amount of solar radiation, and he was thus led to a number 1·6

* "Edinburgh New Philosophical Journal," vol. xxxvi, 1844.

annulled, so that there shall be perfect freedom for convection-currents to flow unresisted in any direction, except so far as resisted by the viscosity of the fluid, and leave the piece of matter, which we may now call the sun, to himself. He will immediately begin showing all the phenomena known in solar physics. Of course, the observer might have to wait a few years for sun-spots, and a few quarter-centuries to discover periods of sun-spots, but they would, I think I may say, probably, all be there just as they are: because I think we may feel that it is most probable that all these actions are due to the sun's own mass and not to external influences of any kind. It is, however, quite possible, and indeed many who know most of the subject think it probable, that some of the chief phenomena due to sun-spots arise from influxes of meteoric matter circling round the sun. The energy of chemical combination is as nothing compared with the gravitational energy of shrinkage, to which the sun's activity is almost wholly due, but chemical combinations and dissociations may, as urged by Lockyer, be thoroughly potent determining influences on some of the features of non-uniformity of the brightness in the grand phenomena of sun-spots, hydrogen-flames, and corona, which make the province of solar physics. But these are questions belonging to a very splendid branch of solar science with which we are not occupied this evening.

What concerns us at present may be summarized in two propositions:

1. Gigantic convection-currents throughout the sun's liquid mass are continually maintained by fluid, slightly cooled by radiation, falling down from the surface, and hotter fluid rushing up to take its place.

2. The work done in any time by the mutual gravitation of all the parts of the fluid, as it shrinks in virtue of the lowering of its temperature, is but little less than (so little less than, that we may regard it as practically equal to*) the dynamical equivalent of the heat that is radiated from the sun in the same time.

The rate of shrinkage corresponding to the present rate of solar radiation has been proved to us, by the consideration of our dynamical model, to be thirty-five metres on the radius per year, or one ten-thousandth of its own length on the radius per two thousand years. Hence, if the solar radiation has been about the same as at present for two hundred thousand years, his radius must have been greater by one per cent two hundred thousand years ago than at present. If we wish to carry our calculations much farther back or forward than two hundred thousand years, we must reckon by differences of the reciprocal of the sun's radius, and not by differences simply of the radius, to take into account the change of density (which, for example, would be three per

* "On the Age of the Sun's Heat," by Sir William Thomson ("Macmillan's Magazine, March, 1862); and Thomson and Tait's "Natural Philosophy," second edition, vol. i, part ii, Appendix E.

cent for one per cent change of the radius). Thus the rule, easily worked out according to the principles illustrated by our mechanical model, is this :

Equal differences of the reciprocal of the radius correspond to equal quantities of heat radiated away from million of years to million of years.

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times theirs. Forty years later Langley,* in an excellently worked out consideration of the whole question of absorption by our atmosphere, of radiant heat of all wave-lengths, accepts and confirms Forbes's reasoning, and by fresh observations in very favorable circumstances on Mount Whitney, 15,000 feet above the sea-level, finds a number a little greater still than Forbes (1·7, instead of Forbes's 1·6, times Pouillet's number). Thus Langley's number expressing the quantity of heat radiated per second of time from each square centimetre of the sun's surface corresponds to 133,000 horse-power per square metre, instead of the 78,000 horse-power which we have taken, and diminishes each of our times in the ratio of 1 to 1·7. Thus, instead of Helmholtz's twenty million years, which was founded on Pouillet's estimate, we have only twelve millions, and similarly with all our other time-reckonings based on Pouillet's results. In the circumstances, and taking fully into account all possibilities of greater density in the sun's interior, and of greater or less activity of radiation in past ages, it would, I think, be exceedingly rash to assume as probable anything more than twenty million years of the sun's light in the past history of the earth, or to reckon on more than five or six million years of sunlight for time to come.

But now we come to the most interesting part of our subject—the early history of the sun. Five or ten million years ago he may have been about double his present diameter and an eighth of his present mean density, or ·175 of the density of water; but we can not, with any probability of argument or speculation, go on continuously much beyond that. We can not, however, help asking the question, What was the condition of the sun's matter before it came together and became hot? It may have been two cool solid masses, which collided with the velocity due to their mutual gravitation; or, but with enormously less of probability, it may have been two masses colliding with velocities considerably greater than the velocities due to mutual gravitation. This last supposition implies that, calling the two bodies A and B for brevity, the motion of the center of inertia of B relatively to A must, when the distances between them was great, have been directed with great exactness to pass through the center of inertia of A; such great exactness that the rotational momentum after collision was of proper amount to let the sun have his present rotational period when shrunk to his present dimensions. This exceedingly exact aiming of the one body at the other, so to speak, is, on the dry theory of probability, exceedingly improbable. On the other hand, there is certainty that the two bodies A and B at rest in space if left to themselves, undisturbed by other bodies and only influenced by their mutual gravitation, shall collide with direct impact, and therefore with no motion of their center of inertia, and no rotational momentum of the

* "On the Selective Absorption of Solar Energy," "American Journal of Science," vol. xxv, March, 1883.

compound body after the collision. Thus we see that the dry probability of collision between two of a vast number of mutually attracting bodies widely scattered through space is much greater if the bodies be all given at rest, than if they be given moving in any random directions and with any velocities considerable in comparison with the velocities which they would acquire in falling from rest into collision. In this connection it is most interesting to know from stellar astronomy, aided so splendidly as it has recently been by the spectroscope, that the relative motions of the visible stars and our sun are generally very small in comparison with the velocity (612 kilometres per second) a body would acquire in falling into the sun, and are comparable with the moderate little velocity (29·5 kilometres per second) of the earth in her orbit round the sun.

To fix the ideas, think of two cool solid globes, each of the same mean density as the earth, and of half the sun's diameter, given at rest, or nearly at rest, at a distance asunder equal to twice the earth's distance from the sun. They will fall together and collide in half a year. The collision will last for a few hours, in the course of which they will be transformed into a violently agitated incandescent fluid mass, with about eighteen million (according to the Pouillet-Helmholtz reckoning, of twenty million) years' heat ready made in it, and swelled out by this heat to possibly one and a half time, or two, or three, or four times, the sun's present diameter. If instead of being at rest initially they had had a transverse relative velocity of 1·42 kilometres per second, they would just escape collision, and would revolve in equal ellipses in a period of one year round the center of inertia, just grazing one another's surfaces every time they come round to the nearest points of their orbits.

If the initial transverse component of relative velocity be less than, but not much less than, 1·42 kilometre per second, there will be a violent grazing collision, and two bright suns, solid globes bathed in flaming fluid, will come into existence in the course of a few hours, and will commence revolving round their common center of inertia in long elliptic orbits in a period of a little less than a year. The *quasi*-tidal interaction will diminish the eccentricities of their orbits; and if continued long enough will cause the two to revolve in circular orbits round their center of inertia with a distance between their surfaces equal to ·644 of the diameter of each.

If the initial transverse component relative velocity of the two bodies were just sixty-eight metres per second, the moment of momentum, the same before and after collision, would be just equal to that of the solar system, of which seventeen eighteenths is Jupiter's and one eighteenth the sun's; the other bodies of the system being not worth considering in the account. Fragments of superficially melted solid, or splashes of fluid, sent flying away from the main compound mass could not possibly by tidal action or other resistance get into the actual

orbits of the planets, whose evolution requires some finer if more complex fore-ordination than merely the existence of two masses undisturbed by any other matter in space.

I shall only say in conclusion: Assuming the sun's mass to be composed of portions which were far asunder before it was hot, the immediate antecedent to its incandescence must have been either two bodies with details differing only in proportion and densities from the cases we have been now considering as examples; or it must have been some number more than two—some finite number—at the most the number of atoms in the sun's present mass, which is a finite number as easily understood and imagined as number 3 or number 123. The immediate antecedent to incandescence may have been the whole constituents in the extreme condition of subdivision—that is to say, in the condition of separate atoms; or it may have been any smaller number of groups of atoms making up minute crystals or groups of crystals—snow-flakes of matter, as it were; or it may have been lumps of matter like this macadamizing stone; or like this stone, which you might mistake for a macadamizing stone, and which was actually traveling through space till it fell on the earth at Possil, in the neighborhood of Glasgow, on April 5, 1804; or like this—which was found in the Desert of Atacama in South America, and is believed to have fallen there from the sky—a fragment made up of iron and stone, which looks as if it had solidified from a mixture of gravel and melted iron in a place where there was very little of heaviness; or this splendidly crystallized piece of iron, a slab cut out of the celebrated aërolite of Lenarto, in Hungary;* or this wonderfully shaped specimen, a model of the Middlesburgh meteorite, kindly given me by Professor A. S. Herschel, with corrugations showing how its melted matter has been scoured off from the front part of its surface in its final rush through the earth's atmosphere when it was seen to fall on March 14, 1881, at 3.35 P. M.

For the theory of the sun it is indifferent which of these varieties of configurations of matter may have been the immediate antecedent of his incandescence, but I can never think of these material antecedents without remembering a question put to me thirty years ago by the late Bishop Ewing, Bishop of Argyll and the Isles: "Do you imagine that piece of matter to have been as it is from the beginning; to have been created as it is, or to have been as it is through all time till it fell on the earth?" I had told him that I believed the sun to be built up of stones, but he would not be satisfied till he knew, or could imagine, what kind of stones. I could not but agree with him in feeling it impossible to imagine that any one of these meteorites before you has been as it is through all time, or that the materials of the sun were like this for all time before they came together and became hot.

* The three aërolites now exhibited belong to the Hunterian Museum of the University of Glasgow, and have been kindly lent me for this evening by the curator, Dr. Young.

Surely this stone has an eventful history, but I shall not tax your patience longer by trying to trace it conjecturally. I shall only say that we can not but agree with the common opinion which regards meteorites as fragments broken from larger masses, but we can not be satisfied without trying to imagine what were the antecedents of those masses.

CREATION OR EVOLUTION?*

By W. D. LE SUEUR.

IN a recently published work, bearing the above title, we have an elaborate plea, drawn by an eminent legal practitioner, against the doctrine of evolution as expounded by such writers as Darwin, Huxley, and Spencer. To satisfy the natural curiosity of the public as to how eminent qualifications as a jurist should have come to be united with competence for a very ambitious essay in biological and philosophical criticism, the author informs us that, for years past, he has found relaxation from severe professional labor in the study, during his leisure hours, of the works of the leading evolutionists. He believes that he has fully mastered both their facts and their reasonings; and, finding the latter very weak—so weak that, in one case, he almost blushes to have to repeat the argument to his intelligent readers—he comes forward to level the whole structure of the evolutionary philosophy, and to rebuild on its ruins the ancient theory of "special creation." It must not be supposed, however, that Mr. Curtis is indebted to previous writers for the arguments he now brings to bear in favor of that venerable position. It is over forty years, he tells us, since he looked into any of the great authorities in the department of natural theology; and he is not now conscious of having "borrowed an argument, imitated a method, or followed an example." It is not often, perhaps, that so extensive a claim can be laid to originality; for most of us, it must be confessed, borrow arguments, imitate methods, and follow examples, often to our great profit, and without, in general, feeling our consciences unduly burdened. There is no doubt in our mind that Mr. Curtis has made an honest effort to understand the writers whom he has set to work to criticise. He has conned his brief with a good deal of care; but the trouble is, as we conceive, that he has held a brief, and has not been in contact with the actual facts. He has taken one or two books of Darwin's, and one or two of Spencer's, and has subjected them to a kind of microscopic analysis; but there is no evidence whatever that either his reading or his observation has been of a character to enable him to do justice to the doctrine of evolution as a whole. He has not even read enough of the authors he criticises to

* Creation or Evolution? A Philosophical Inquiry. By George Ticknor Curtis. New York: D. Appleton and Company.

have mastered their terminology. See, for instance, his very futile and pointless criticism of the term "noumenon," as used by Mr. Spencer. Upon almost every page of his book we are made to feel that he has never really breathed the same air as the writers whose names he so continually repeats, and with whose works he professes so minute an acquaintance. He knows them simply as a counsel knows the opposite party in a suit—some one of whom he never heard before he got his instructions from his client or client's attorney, and of whom he does not want to hear any more after the trial is over.

We have tried to do justice to the extreme originality of this writer's methods, but without marked success. The patent laws of most countries, we believe, refuse to grant exclusive rights in connection with mere *processes*. A man can get a patent for a new kind of spade, but not for a new way of handling an old spade, supposing such were discoverable. Well, all we have been able to perceive in the somewhat heavy volume before us is a process, which may indeed strike the author as original with himself, but which strikes us as exceedingly familiar, and as being within very easy reach of any one whose knowledge and reasoning faculties are in a sufficiently undeveloped state to permit him to use it. It seems to consist in saying, as often as the evolutionist points to anything as exhibiting marks of relationship with anything else: "Oh, no! God made that exactly so, by a special act of creation, for wise purposes of his own." Sometimes Mr. Curtis feels sure he can indicate the purposes, and then of course the argument moves triumphantly on; at other times he acknowledges the purposes to be hidden, and then he falls back, with calm and pious assurance, on the fundamental principle that the Creator, being infinite in wisdom, must have had an infinitely wise end in view in everything that can be traced to his hand.

"All correct reasoning," says our author, "on the subject of man's descent as an animal begins, I presume, with the postulate of an Infinite Creator, having under his power all the elements and forms of matter, organized and unorganized, animate and inanimate." This declaration gives the key-note of the work, and it perhaps also affords a measure of its philosophical value. To all who are conversant with the use of philosophical terms, it will be evident that the author has but an imperfect idea of what is commonly meant by a "postulate." *He* means by it a principle which he intends to apply to the interpretation of all facts; others mean by it a principle, the non-recognition of which would render all inquiry impossible. The difference is obvious and important. In the ordinary and legitimate sense of the word "postulate," the existence of an infinite Creator can not possibly be a postulate. It may be considered either as a fact or as a theory. If it is a fact, it does not need to be postulated—it is enough to appeal to it; if it is a theory, you can not postulate it without giving it more authority than, as a theory, it ought to have. What we have to do with

theories is to test them by facts, not to erect them into final and absolute standards. We do not imagine that Mr. Curtis will claim that no inquiry into man's descent can be carried on without assuming the existence of an infinite Creator, such as he describes. To such a claim, if made, the immediate and appropriate answer would be, "*Solvitur ambulando.*" Such inquiries are, in point of fact, being conducted every day, without any reference to that particular theory, simply by the aid of such facts and analogies as a study of Nature furnishes. It is quite open, of course, to Mr. Curtis to set such bounds to his own inquiries as he may approve of, and to exercise his originality to the full in devising canons of interpretation for the facts which investigation brings under his notice; but he should really not ask us to accept the special opinions by which he, as an individual, chooses to be guided, as the ultimate and indispensable conditions of all research. We are quite prepared to arrive at his opinions as the result of inquiry, if the evidence appears to be in their favor, and shall be only too happy to find ourselves in agreement with so potent a logician; but we are not prepared to "postulate" anything that is not absolutely necessary to intellectual movement.

If it should be said that Darwin himself postulated (even in the loosest sense of the word) an infinite Creator, we should meet the statement with a simple denial. Darwin expressed himself on a few occasions in language pointing to a theistic belief; but never so as to imply that the conclusions to which he might be led by a study of Nature were to be checked by general reasonings founded on the nature and attributes of an infinite Creator. One great point of difference—not to mention others—between Darwin and his present critic is that the former was profoundly conscious of his entire inability to speculate intelligently concerning what an infinite Creator might or might not, should or should not, would or would not, have done. Far from being conscious of any such inability, Mr. Curtis seems to entertain no doubt whatever of his perfect competency to discuss and settle questions as to the *probable* mode or modes of special Divine action. In one place, indeed, he admits that "we can not penetrate into his" (the Almighty's) "counsels without the aid of revelation"; but, on the very same page, he claims to be able to see sufficiently far into the purposes of God to warrant him in believing that "acts of special creation are vastly more probable than the theory of evolution." Throughout the book, indeed, we are continually being called upon to agree with the author that some particular method of action is a much more "probable" one for the Supreme Being to have adopted than some other (evolutionary) process. It does not appear to have ever struck the learned and acute author that such language may savor of impiety even to evolutionists. Where, it may very pertinently be asked, has Mr. Curtis obtained the knowledge that enables him to judge what are the probable methods of Divine action? We

can understand how a man might obtain such an acquaintance with the literary or artistic style of some human author or artist, as should embolden him to pronounce an opinion as to whether a certain piece of work was or was not from the master's hand; but we do not see that any one has it in his power so to con the works of Deity as to authorize him in saying that he knows the Divine style, and is therefore in a position to decide which of two plans of action is most in harmony therewith. We have before us simply the facts that Nature presents; our task is to see these in the most rational order possible, knowing well that, however enlarged our knowledge may become, a *perfect* interpretation of the facts will forever be beyond our reach. Whatever view, therefore, may at any moment best colligate and harmonize the phenomena of the universe, that view—if we are going to concern ourselves with Divine plans—we must regard as most nearly revealing the Divine plan. But to allow our interpretation of the phenomena to be overborne and controlled by any *a priori* conceptions, such as Mr. Curtis seeks to force upon us, of the Divine nature and attributes, is simply to abandon science and betake ourselves to dogma and mysticism.

Now, to be quite frank, we don't believe Mr. Curtis is one bit better a judge of the Divine style in creation than the very humblest among us. It is puzzling enough to know how merely superior human faculties will work. The child can not understand the mind of its father in matters beyond its own experience, and can not see the wisdom of its father's actions. The inferior man can not understand the mind of the superior man. We can hardly imagine anything more ridiculous, certainly nothing more hopeless, than an attempt by weak or undeveloped minds to comprehend the workings or appraise the manifestations of minds of a higher order; yet what is the interval between the youngest child and its parent, between the most uninstructed peasant and the mightiest philosopher, compared with that existing between, say, Mr. Curtis, and that mind which he proclaims to be infinite, yet offers to interpret for us? Surely, then, it is not without good reason that the leading scientific investigators of our day have decided on conducting their researches in entire independence of all theological assumptions. They feel instinctively that the moment they begin to draw deductions from theological premises, even the most plausible, their conclusions cease to have scientific validity, and that science itself becomes a mere aborted appendage to theology.

It is time, however, to proceed to a somewhat closer examination of the work before us. The author is much struck, in the first place, with the parallel he finds existing between the Platonic theory (or rather myth) of creation as developed in the "Timæus" and the Darwinian theory of the origin of species, including the human. We fail, for our part, to see much resemblance between a myth in which everything which is referred to the arbitrary and purposive acts of an imaginary divinity, and a scientific theory which ascribes all growth

and development to the unceasing operation of laws inherent (as would appear) in things themselves. What strikes us with wonder, however, is that our author, after explaining that on Plato's theory man was first made, and after him the other animals in the order of their dignity, the lowest forms of aquatic life coming last, should proceed to say that there is as much in Nature to support this view of creation as to support the Darwinian theory, according to which life, beginning with the lowliest forms, worked upward to the highest. These are his words: "Nor had Plato less of probability to support his theory than Darwin to support his. . . . If Plato had known as much about the animal kingdom as is now known, he could have arrayed the same facts in support of his theory by an argument as powerful as that which now supports the doctrine of evolution" (pp. 73, 74). This, in face of the fact that the geological record is there for every one who has eyes to read, showing that the highest forms of life were *not* first in the order of creation or development, but last, and the lowest forms first! Surely it is not the doctrine of evolution that will suffer by such an attack as this. The influence of the "postulate" must have been making itself very strongly felt when the author contrived to overlook simply the broadest, the most conspicuous, and the most important fact of all bearing on the question of the relative claims of the two theories he was comparing. It is not an encouraging example of the effect of theological or metaphysical prepossessions. The Platonic theory of the soul has also, it would seem, made much impression on our author. The Demiurgus makes it entirely "distinct from matter," and places it in some star, where it is to await the birth of the body with which it is destined to be united, and which it is to govern, if it can, "according to the eternal laws of reason and rectitude." If it succeeds in this duty, it flies back at the death of the body to its own star; if not, it passes into some more degraded body, for the purpose, apparently, of getting another chance under worse conditions. "Stripped," says the writer, "of the machinery by which Plato supposes the soul to have come into existence, his conception of its origin and its nature is the most remarkable contribution which philosophy, apart from the aid of what is called inspiration, has made to our means of speculating upon this great theme." Surely it is not our "means of speculating" upon this or any other theme that we want to have enlarged; it is our knowledge of the facts of the case; in general, the less we know the more freely we can speculate. We fail to see that as a contribution to *knowledge* the Platonic conception is of any value whatever.

The strictly scientific arguments brought by our author against the doctrine of evolution present, we feel justified in saying, no character of originality. They are such as every one in the least acquainted with the literature of the subject is thoroughly familiar with. Against Darwin is urged the absence of the intermediate forms which, upon his

theory, ought to be discoverable, the apparent immutability of species, the infertility of hybrids. Whether it was worth while at this time of day to write a somewhat lengthy treatise, for the purpose of putting forward arguments so thoroughly known, is a question on which opinions may differ. We do not mean that the arguments themselves are not deserving of attention; but we do mean that they are very accessible to the reading public in a great many quarters, and are nowhere, probably, stated with greater force than in the writings of the evolutionists themselves. Such as it is, however, the scientific argumentation of this volume is interwoven throughout with argumentation of a purely theological character. The author would, possibly, call the latter philosophical; but, with every desire to be just, we think that term would be misapplied. Take the following as an example of the kind of thing we refer to: "Why depict the infinite God as a quiescent and retired spectator of the operation of certain laws he has imposed upon organized matter, when there are discoverable so many manifest reasons for the special creation of such a being as man?" Here we have Mr. Curtis talking in his usual off-hand way of the Divine Being as being swayed by "reasons," and of these reasons as being discoverable by ordinary human understanding. Have all the lessons of the Book of Job, to say nothing of the "Critique of Pure Reason," been lost upon this latest foe of evolution? It would seem so. Again we are told, in the most magisterial manner, that "in the economy of Nature, which is but another name for the economy of the Omnipotent Creator, there is no waste of power, as there is no abstention from the exercise of power, when its exertions are needed to accomplish an end." Can any one attach a rational meaning to the word "waste" as applied to that the supply of which is infinite? If we imagine, for one moment, the Creator being arraigned for something that, to finite intelligence, looked like waste, might not his reply be that he had infinite reserves of power which were not being put to any use at all? And if the finite intelligence were to rejoin that this was waste on a yet larger scale, what should we have but one more illustration of how hopeless it is for the finite mind to grapple with the infinite and absolute? Working, however, upon his double principle that the Deity never wastes power, yet is always willing to exert the full amount needed for the accomplishment of his purposes, our author is led to disbelieve entirely what the evolutionists assert in regard to the derivation of the human species from lower types of life. As he interprets the facts, the Deity *economized* power by making man on the same general plan as the rest of the mammalians, instead of drawing entirely new plans for him; and at the same time *expended* power in creating those specific differences which constitute him Man. A delicate question might here arise as to whether the various "rudiments" found in the human frame were left there through a prudent economy of power, or placed there by a wise exertion of power. We should

rather Mr. Curtis would discuss the point than we; for we really can not profess to understand either the economy that could have accompanied the reduction of structures, well developed in other types to the rudimentary condition in which they are found in man, or the wisdom of producing, by a fresh exertion of power, that which was functionally useless.

Our author combats in turn nearly every position taken by Mr. Spencer in his exposition of biological evolution. To Mr. Spencer's statement that not only did no one ever see a special creation take place, but "no one ever found indirect proof of any kind that a special creation had taken place," he affirms that indirect evidence has been accumulated to an enormous extent to show that the earth is full of "special creations." If no one, he proceeds to say, ever saw a special creation take place, neither has any one ever seen an instance in which an animal of one species has been evolved out of another of a different species. Considering that the evolution of a species is conceived and uniformly represented as a process requiring multiplied generations for its accomplishment, whereas special creation, if it ever occurred before witnesses, would, we must suppose, be as observable a thing as the shooting of a meteor across the sky, the cases are not quite parallel. Of course, it is open to the creationist to say that no act of creation has taken place since man was called into being; but if so, it must be admitted that the evolutionist, who does not require to say that the processes in which *he* believes came to a stop very long ago, but who affirms, on the contrary, that the laws of evolution are just as active now as they ever were, has slightly the advantage. Moreover, the evolutionist, if he can not crowd centuries into an hour, and show the transformation of species and genera accomplishing itself before our eyes, can point to changes now in progress which, if continued through the ages, could not fail to produce the widest divergences in animal and vegetable forms. The creationist has absolutely nothing to show us that hints at or points to creation as the term is commonly understood—the flashing of something out of nothing. Mr. Curtis would fain persuade us that Shakespeare's production of "Hamlet" is an act of creation analogous, comparing small things with great, to the creation of the world. The idea is a little preposterous. Did "Hamlet" come out of nothing in any sense whatever? Was it not a special combination of ideas, experiences, imaginations, conceptions, that were part of the personality of the dramatist? And these experiences, imaginations, etc., were they not the result of the author's contact with the outer world? Are not all the words used to express even our most abstract mental operations, borrowed from the phenomena of daily life? The fact that "Hamlet" was not a creation in the theological sense is proved by the simple consideration that it was the work of the individual William Skakespeare, and came forth from his brain *as it could not have come forth from any other brain.* Why should a

creation from nothing have any special character? Other things bespeak their origin in their lineaments; and, until better advised, we shall continue to think that a creation out of Nothing would look uncommonly like—Nothing. If a man born blind were, by an act of imagination or what not, to show himself quite at home in the comprehension of the phenomena of light, we should perhaps be disposed to recognize an analogy to the alleged work of creation; but we are not aware that any such achievement has been recorded. That a great thinker or poet should not always, if ever, understand how thoughts came to group themselves in his mind in any particular way is no difficulty to the evolutionist: he does not pretend to understand all the mysteries of the human organization.

One argument used by Mr. Spencer affected our author, as he tells us, very strangely. As he read he could hardly trust the evidence of his eye-sight; he thought the type must have got topsy-turvy in some strange fashion; he began to distrust the accuracy of the American edition of the philosopher's works, such an extraordinary example did he seem to have before him of "logic run riot." No doubt it was an argument that would not have told very powerfully on a jury; and that might not have brought much light even to the mind of an average judge, as it certainly has been quite lost on that of a distinguished lawyer; but the argument in our humble opinion is a good one, for all that. What Mr. Spencer says, to put it briefly, is that the idea of creation is unthinkable because it implies a relation between something and nothing. What has Mr. Curtis, after recovering from his spasm of astonishment, to say in reply? The first thing he says is that the creation of matter is not inconceivable, "if we adopt the postulate of an infinite Creator." In other words, use certain expressions that formally signify creation out of nothing, and forthwith we have the conception, clear and workable. In the same way, if we want to have the conception of a round square, we only have to say "round square," and presto, there it is! Mr. Curtis wants very badly to know who made the laws that have been "impressed upon matter"? But who knows that any laws have been "impressed upon matter"? Who knows that that is the proper way of expressing the relation between matter and its laws? Does Mr. Curtis know it? We doubt it; or rather we may say that we know that he does not *know* anything of the kind. By the so-called "laws of matter" are meant simply the properties of matter. Perhaps Mr. Curtis thinks he can conceive of matter apart from its properties, and of the properties apart from matter. Be that as it may, the question of the origin of the properties of matter is plainly a part of the question as to the origin of matter. All that Mr. Spencer says is that there is no use in talking of matter, or anything else, coming out of nothing, seeing that the words, when you press them, will be found void of meaning. When Mr. Curtis says that "the term 'creation,' as used in all modern

philosophy, implies *ex vi termini*, the act of causing to exist," the answer to give is that the term "creation" is not used in "all modern philosophy," and that the idea of creation has a very small place indeed in modern philosophy. Professor Eucken, of Jena, in a useful little hand-book, which has been translated by a professor at Andover and furnished with an introduction by the ex-President of Yale, has catalogued and commented on "The Concepts of Modern Philosophy." Mr. Curtis will search the list in vain for any mention of the concept of "creation"; and it is a perfectly safe statement to make that the idea in question is not an element of any importance in contemporary philosophical thought.

Mr. Curtis says many odd things without being in the least aware of it. He describes lexicographers as "learned persons, part of whose business it is to exhibit the thought that is represented by a word, . . . according to the exact correspondence between the word and the idea which it conveys in its primary and philosophical usage." A very little reflection, aided by a small amount of inquiry, would have sufficed to satisfy him that the primary sense of a word and its philosophical sense are seldom, if ever, the same. He tells us that, according to his famous postulate, "the whole void which consists in mere nothingness" is "under the absolute sway" of the Creator. Could more nonsensical language possibly be put together? Imagine the Creator swaying "nothingness"! How much power does it take to do it? What effect has it upon "nothingness" to be "swayed"? Has it all been "swayed" yet, or is some of it still unswayed? These questions are all quite pertinent and quite absurd; and, when a question is at once pertinent and absurd, it is evident that something is wrong with the matter to which the question relates. Mr. Curtis would not believe Mr. Spencer when the latter told him that the idea of creation was unthinkable; he thought he knew better, and now we find his supposed superior knowledge leading him to represent the Almighty as *swaying nothing*. Mr. Spencer knew it would come to that; and, should he find time to look at Mr. Curtis's book, he will have no such shocks of surprise as Mr. Curtis had in reading his. Our author further tells us that "the theologian is not the only person who has occasion to examine the doctrine of evolution; it must be examined by the statesman as well." By all means! Let theologians, statesmen, and lawyers all examine it, and whosoever will let him examine it; only let this caution be whispered into each one's ear, that it requires a little preparation to examine it to any good purpose. Our author is not the only prominent lawyer who has failed to make much of it. He will find a sympathizer in Mr. Chauncey M. Depew, who told the Nineteenth Century Club, not so long ago, that, down in Wall Street, the whole phraseology of evolution would be quite unintelligible. We don't doubt it; a comprehensive system of philosophy, founded on a very wide range of induction, is apt to be incom-

prehensible to people who have not given it patient and prolonged study.

Our author appears to be in possession of some very definite information respecting the solar system, not set down in the ordinary treatises on astronomy. He knows that it was "arranged with reference to the law of universal gravitation," that "the existing arrangements must have been intentional," that "there is the strongest evidence that a certain means was chosen and intentionally put into operation." The Creator, however, he explains (page 183), "does not meet an external demand." He creates the demand or purpose himself and then satisfies it. What kind of "purpose" that can be that has no relation to any need the writer does not explain, though, of course, he knows. Strange to say, we read a little farther on (page 207) that the Creator is "governed by a purpose in all that he does." Does this mean that the Creator ties his own hands by the purposes that he forms without any reference to external demands? Again, we are assured with tiresome iteration that the Creator does nothing that is "useless." Useless to whom? To himself? Or to an external world? If to himself, the remark seems senseless; if to an external world, then there *is* the meeting of an external demand.

But if, on the one hand, our author knows many remarkable things that are not known to the world at large, there are other things quite within the range of his reading of which he seems to have remained willingly ignorant. He wants to know (page 214) how it came to be imposed upon a whole group of beings, as a law of Nature, that whatever utility of structure was of paramount importance to the whole group should be preserved against the modifying influences that were destined (on the theory of evolution) to produce species differing absolutely from each other." The answer is, of course, that any deviation from a structure that was of *paramount utility* would consign the organism manifesting it to destruction; and that eventually the typical organization would by age-long inheritance become so stamped into the constitution of those sharing it that a deviation of any moment would become matter of simple impossibility.

Taking the work before us as a whole, we may say that, while it evinces a creditable amount of industry on the part of its author, and while, as a piece of special pleading against the hypothesis of evolution, it shows an ingenuity that, in another sphere, must possess considerable value, it betrays an altogether insufficient acquaintance with the data on which the hypothesis in question is founded, and is, moreover, vitiated by the constant use of an assumption which Kant has abundantly shown to be an altogether illegitimate starting-point for scientific inquiry. The most serious injustice it does to the doctrine of evolution is in representing it as an irreligious system of thought. No scientific doctrine can by any possibility be irreligious, for the most that science can do is to indicate the limits of the known and

the unknown. To do this is not to destroy the grounds of religion, though, as science advances, doctrinal and historical systems may have to undergo progressive modifications. It is one thing to be asked to change the form of religion, and quite another to be summoned to part with its substance. The latter demand has never, so far as we are aware, been made in the name of science by any authorized exponent. It is no new thing for religion to go forth in search of new ground. Suppose that we have now frankly to acknowledge that the old conceptions of special creation and providential design are no longer tenable in the light of modern knowledge, shall religion fail from among us? Never, unless we are willing it should fail. If we ourselves are faithful, Religion, though she may have to abide for a time in tabernacles, will still be with us, and all our thoughts and all our investigations will be hallowed by her influence. Evolution is simply the current form of scientific opinion; we adhere to it because it seems to be the truth. Religion is that instinct in man which leads him to recognize and worship that which is highest and best. Far, then, from our submission to the truth cutting us off from religion, it should, and it will, bring religion nearer to us, and enable us some day to place it upon imperishable foundations, and to make it the abiding consecration of all thought and effort.

MEGALITHIC MONUMENTS IN SPAIN AND PORTUGAL.

By the Marquis de NADAILLAC.

NOTHING in the ancient history of man is of more considerable interest than are those monuments, at once rudely grand and mysteriously simple, which have been designated megalithic. They may be simply raised stones, isolated menhirs, cromlechs arranged in a circle, or artificial caves formed by placing flat flags horizontally on standing supports. Dolmens or covered passages were usually buried under masses of earth or stones, so as to form veritable tumuli; but they always present the common character of being constructed in rough blocks, virgin of all human labor.

Megaliths are important on account of their number* and their dispersion. They are to be found, with a likeness running through them all, in places most remote from one another, on different continents. At Carnac and at Kermarin are immense rows of stones, of

* A French sub-commission on megalithic monuments was appointed in 1879, for the purpose of assuring the preservation of the more important among these structures. An imperfect count, made under its direction, raised the number of dolmens, menhirs, polissoirs, basin-stones, and rocking-stones, still standing in France, to 6,310. Tumuli, which are very numerous, are not included in this enumeration.

which the menhirs of the Khasias of India appear like exact copies. Similar dolmens are standing in Palestine, Ireland, and Hindostan. Megaliths can be found in Peru and among the aboriginal monuments of North America, in Spain and Denmark, in the Orcades and the islands of the Mediterranean, on the shores of the Black Sea and of the Baltic, at the foot of Mount Sinai, and in Iceland at the edge of the eternal glaciers. The dolmens raised upon the top of a tumulus in Algeria may be compared with those standing in the department of the Aveyron or with those in Kintyre, Scotland, and Röskilde in Scandinavia; the cromlech of Maytura, in Iceland, with that at Halskov, in Denmark; the circle at Peshawur, in Afghanistan, with the circle of Stennis, in one of the Orcades; the tombs of the Neilgherries with the *chondets* that are found in Africa; the cromlechs of Algeria with those of Aschenrade, on the Dwina; the triliths of Stonehenge with those of Tripoli, or those mentioned by Palgrave as in Arabia. Even a superficial study will disclose the relations that exist between the covered passages of Provence and the megaliths of Brittany, and between these and analogous constructions in Spain and Algeria. A common thought, and an identical funeral rite, are revealed.

M. Cartailhac, for many years editor of the "Materiaux pour servir à l'Histoire de l'Homme" ("Materials to be used for the History of Man"), has, in a recent book on "Prehistoric Ages in Spain and Portugal" ("Les Ages préhistoriques en Espagne et en Portugal"), described some remarkable monuments in the Iberian Peninsula, most of which have not been previously brought to the scientific attention of students in other countries. The megaliths of Portugal consist in a great part of dolmens, or *antas*, as they are called there. Three hundred and fifteen of them were known in 1754. Some of them have disappeared; but though Pereira de Costa could report upon only thirty-nine at a conference held in connection with the International Exposition in Paris in 1867, Gabriel Pereira, a short time afterward, enumerated one hundred and eighteen, and these were mostly situated in the province of Beira and near Evora and Elvas, in Alemtejo.

In every country the rocks are disintegrated by the effect of weather-changes into large blocks. The megalith-builders chose those blocks for their purpose which offered the fairest surface. The inclosure was hollowed out. The stones chosen for the walls of the burial-chamber were raised, planted in the soil, and covered with large flat stones; and then the interstices were filled up with pebbles. A low, narrow entrance-gallery was made by a similar method, and, after the funeral rites were performed, the crypt was covered with a tumulus—a protecting envelope which has in most cases been removed long ago under the impulse of curiosity or with the hope of finding hidden treasures. The few dolmens still buried are called *mammoas* or *maminhas* (*mammæ*), from their peculiar form.

These antas frequently served for a considerable number of burials each, and in that case the entrance-gallery seems to have been kept open. At other times, a single corpse was deposited, and the crypt was closed, as the friends thought, forever.

Notwithstanding it has suffered considerable mutilations, the crypt of the great anta of Freixo (Fig. 1) is still standing, although the corner-stone has disappeared and the covered gallery has become dilapidated. The walls of the crypt, which is 4 metres in diameter, are composed of seven stones, 3·80 metres high, while the entrance is only 45 centimetres wide.

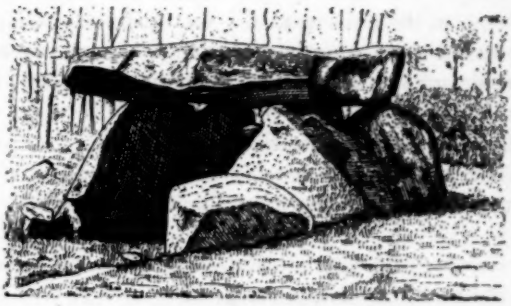

FIG. 1.—ANTA OF THE WOOD OF FREIXO.

Numerous antas have been explored at various times in search of the treasures which popular traditions suppose to be hidden in them; and scattered bricks, pieces of pottery, iridescent glass, and rubbish of the Roman period, testify to the energy of the diggers. The neolithic articles under the dolmens which remain unviolated are similar to those in the megaliths of the neighboring countries. The anta of Portimão has furnished hatchets, stone adzes, steatite heads, and admirably worked arrow-heads; that of Monte-Abrahão* hatchets of trap and diorite, stone scrapers, a button of bone and pearls of Calais, that precious stone described by Pliny and remaining unknown from his time; the anta of Estria, a curious plaque of slate covered with straight or broken lines and resembling an episcopal crozier in shape; and the dolmen of Nora, besides flakes and finely cut arrow-heads, a highly ornamented ivory disk, the use of which it is hard to determine. The burial-place of Marcella (Fig. 2), a regular cromlech, is one of the richest in funeral paraphernalia. There have been collected from it, together with fine specimens of flint-flakes, retouched on the edges, and of triangular points, three vases covered with ornaments, and forty-three hatchets, nearly all of diorite, and remarkable specimens of work.

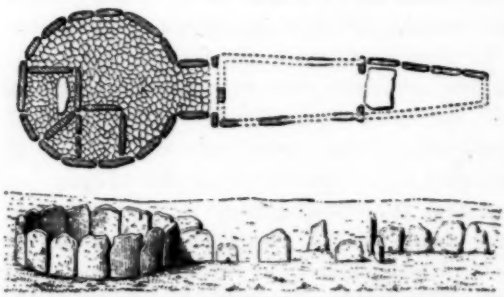

FIG. 2.—BURIAL-PLACE OF MARCELLA, ALGARVE—PLAN AND PROFILE VIEW.

* Human bones, belonging to more than eighty persons of all ages and both sexes, have been collected from within this dolmen.

Some human bones lay in the midst of these memorials of human wealth. Unfortunately, they have been scattered.

We can not leave the antas of Portugal without mentioning the bowls which M. Cartailhac observed on some of the megaliths of Alemtejo. Such vessels have long been known in prehistoric archæology. They are found in Switzerland, in the Pyrenees, in Brittany, in Scotland, in Scandinavia, and on the rocks of Hindostan. The bowls, engraved on the walls of some of the crypts, recently disengaged from their earthy envelope, have doubtless, as M. Cartailhac observes in relating his discovery, an indisputable antiquity, value, and meaning; but we can not determine the age, and the value and meaning are unknown to us. Megaliths are especially abundant in Estremadura, the richest province in Roman Spain, now the most wretched and least populous. They are called *garitas* by the peasants of the province, but farther north, in the Asturias and the Basque provinces, they are known as *arcas*. A most remarkable example of these works is situated at Equilaz, on the road from Vittoria to Pampeluna. The chamber is of a horseshoe-shape, 5·70 metres long and 4·50 metres wide. It was crowned by a single stone, which had been broken recently. Another, nearly similar, with an approach covered with three large flat stones, and a narrow entrance-way, is still to be seen at Caugas de Oñu, 60 kilometres from Oviedo. We also mention the megalithic sepulchres in the province of Barcelona, at Pla-Marshall, and the one near Villalba-Saserra, known as the *Pedra arca*. Both of these are placed in the center of a cromlech formed of stones planted in a standing position. The ruins of the covered ways giving access to the crypt are still visible. Thirteen megalithic crypts are described as remaining in Andalusia and the ancient kingdom of Granada. The structures were formerly much more numerous; but they have been destroyed in the processes of agriculture or in the search for minerals. Such a fate has overtaken the important monument of Dilar, two leagues south of Granada.

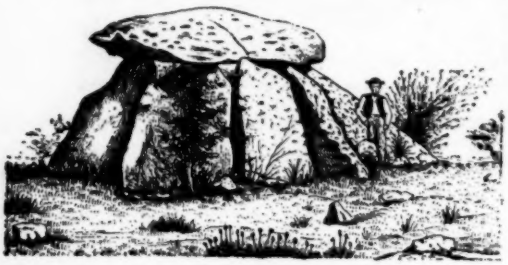

FIG. 3.—ANTA OF PAREDES, NEAR EVORA.

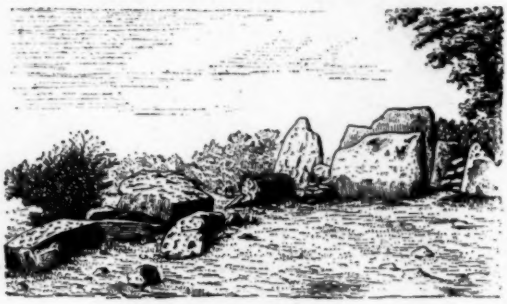

FIG. 4.—LAPA DOS MOUSOS.

But indisputably the most remarkable megalith in Spain is the Cueva de Mengal, near the village of Antequera, province of Malaga (Figs. 5, 6, 7). The walls of the sepulchral chamber are composed

FIG. 5.—COVERED PASSAGE OF ANTEQUERA—VIEW OF THE ENTRANCE.

of twenty stones, and are crowned with five stones, while solidity is assured by setting three pillars in the interior, at the junctions of the roof-tables. Contrary to what we have hitherto observed, the stones of the walls have been rough-hewed, and those forming the pillars even

FIG. 6.—COVERED PASSAGE OF ANTEQUERA—INTERIOR VIEW.

seem to have been cut. The crypt is 24 metres long, and has a maximum breadth of 6·15 metres, and a height varying from 2·70 metres to 3 metres. It is one of the largest crypts known. The chamber of the dolmen of Pastora, farther west, beyond Seville, is 27 metres long and only 1 metre wide and 2 metres high. The excavations of Pastora have yielded thirty bronze arrow-heads.

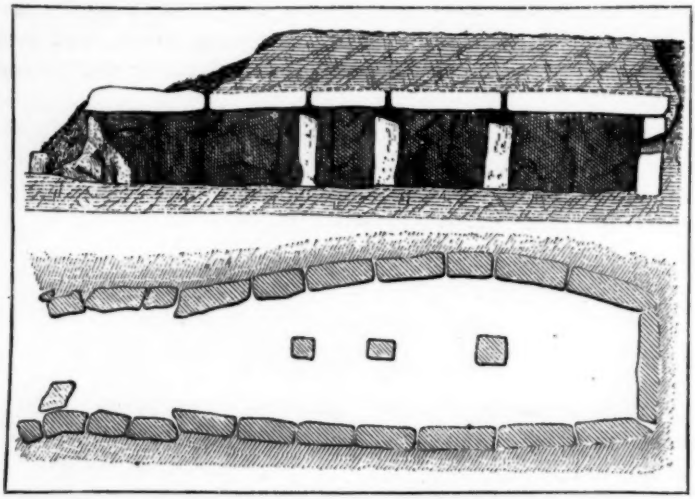

FIG. 7.—COVERED PASSAGE OF ANTEQUERA—SECTION AND PLAN.

The age of the megaliths still presents an unsolved problem. It is probable that if the most ancient ones date from neolithic times, their construction was continued through many generations as an ancestral tradition; and we find them still being built when copper, and afterward when bronze, took the place of stone. There are also in Alemtejo and in the Algarves important cemeteries, in which the great crypts, covered alleys and tumuli are replaced by stone coffins measuring 2 metres long and half a metre deep. The walls are generally formed of six flags, the bottom and lid of other flags. We reproduce one of these tombs (Fig. 8), which is situated at Cerro del Castello, and probably dates from the bronze age. Another tomb, near Odemira, contains broken bones, and with them arms and utensils of stone, and an arrow-head, and a hatchet of copper, without any admixture of

FIG. 8.—PLAN OF CERRO DEL CASTELLO, ALGARVE.

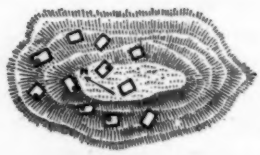

FIG. 9.—PLAN OF THE TOMBS OF THE CORTE DE GADIANA.

tin. Here we are witnesses of the transition between two distinct epochs; and, as in several other countries in Europe, pure copper is the first metal employed.

A new funeral rite responds to these new times. Incineration, imported, doubtless, by foreign conquerors, takes the place of inhumation. Cists of a reduced size (Fig. 9), urns, covered with large stones, receive the ashes, and the few fragments of bone that escape the

flames, the last vestiges of that which was a man. We are touching upon the epoch when history begins. Megaliths are no longer raised in Europe. They remained for a long time an unimportant memorial of barbarous populations; and it is only in our days that they have been restored to their true place in the history of art and of human progress.—*Translated for the Popular Science Monthly from La Nature.*

SOCIAL SUSTENANCE.

GENERAL PRINCIPLES AND DEFINITIONS.

By HENRY J. PHILPOTT.

THE study of the relation of organized society to individual sustenance may, for brevity, be called the science of social sustenance. This means practically the same as the term political economy in its original significance. Economy means housekeeping or husbandry, or making a living. Political economy is housekeeping as affected by social and political conditions. The word "sustenance" means making a living, with or without a house or home, and with all that the term "living" implies when used in that way. Making a living is not merely keeping body and soul together. It is supplying all the physical, moral, and mental wants, in so far as conscious, irksome effort is required to supply them. What is a living to one man is not to another; but the man who makes his own living is always called self-sustaining. *Sustenance*, therefore, is the making any kind of a living.

Social sustenance is making a living as affected by social conditions. Social conditions are the conditions brought about by the existence and conduct of other people. Exactly what social sustenance means, then, is *making a living* as affected by the existence and conduct of other people.

The study of political economy begins the moment we try to think how our making a living is affected by other people. The infinite multitude of ways in which this happens may well discourage us. But we do not have to understand all of them, nor even know all of them. We have to classify them—rudely at first, and afterward as fully as we can. The most general classification of the ways in which others affect our ability to make a living is this: 1. They may hinder us in it. 2. They may help us in it.

So it is all a question of the help and hindrance others give us in making a living. If this division into help and hindrance seems trivial, it only *seems* so, for it is not. It has to be kept in mind all the way through our study. A policy which is boasted of as enabling us to increase our mutual helpfulness, as socialism, for instance, may or it may not increase our tendency to hinder each other. If we wish to reach a right conclusion we have always to ask whether the added

hindrance does not overbalance the added help. If we ignore social hindrances to individual well-being, we shall come out just where the mechanical inventor does who ignores friction.

These hindrances arise in various ways. The very existence of our fellow-beings, if in too large numbers, is a hindrance. We may denounce Malthus as much as we like, but we can not deny the awful consequences of world-crowding. Doubtless it has goaded on inventive genius, and thus promoted mutual helpfulness; but, like most social causes which work remote good, it has worked also immediate evil, and the bones of its pallid victims lie buried in the earth by countless millions. Many writers have been troubled about the matter, and especially about the future it seems to promise. Others have succeeded in convincing themselves that there is no danger, and that the denser the population the happier the individual. The truth which they distort into this error is that the evil effects of world-crowding have been partially offset, in some places more than offset, by new discoveries which cheapened production. It was not always so, and may not always be so. Certainly there are no more new continents to discover. How many new substances, or new powers and uses of old ones, are yet to discover, can not be guessed. But meantime world-crowding, the natural increase of the human species, is going on, and is constantly thrusting human beings into one another's way. We might as well face this truth as deny it, if we are going to study science. Our shrinking from a truth because it is disagreeable, unfortunately does not make it a whit less true. Up to a certain point, and it is a movable point, increase of population is beneficial. There is a certain density of population which is more desirable than any other—than any greater or any less. This movable point of most desirable density of population is moved constantly upward by the inventors who crowd the Patent-Office, by the projectors of great enterprises, and by the skillful organizers of industry; as well as by the statesmen who simplify and perfect the government, and the religious, moral, and economic teachers who facilitate adjustment of the relations of crowding and jostling human beings. As the bounds are thus extended, population grows and fills them—sometimes not quite, but alas! sometimes it quite outgrows them. Before any other explanation of the wretched condition of a community is offered, this one of population should be fully considered.

The grave question which each one asks himself as he gazes upon his own offspring, and wonders what will be the condition of their offspring some generations removed, is, Will this world-crowding relieve itself by checking reproduction as well as by stimulating mutual helpfulness; or will the time come, and how soon, when the only possible object of economic study will be to postpone the universal poverty and starvation of the human race, rather than, as now, to constantly better its condition? If a satisfactory answer to this ques-

tion is possible, it has not as yet been satisfactorily rendered. But assuming the most dreaded answer to be the true one, we may still work on just the same, content to know that the greater legacy of betterment we leave them, the longer our children will be able to put off their hard fate. And besides, even in this day, we, too, find ourselves crowded out of work, or out of the market, by our needy fellow-beings, and thus hindered in trying to make our living.

But in other ways our fellow-beings hinder and shorten our sustenance. They rob us on the highway, break and plunder our inclosures, steal our purses. These are the simpler and ruder ways. They defraud us in a thousand ways. They embezzle and default. They organize gigantic schemes of plunder. And all these things necessitate laws, and governments to make and execute them, which cost immense sums of money. The Government of the United States alone costs nearly or quite as much as the annual savings of the people; though from this must be deducted the school, post-office, and other similar expenses, which would have to be paid privately if they were not paid publicly. Still, allowing one half for these purposes, the cost of government alone, to say nothing of the quarrels and crime which make it necessary, would, if saved, constitute a third of our annual savings.

But not only do (1) the existence in excess, and (2) the consciously perverse conduct of our fellow-beings hinder us in making a living; even when they do their best, the (3) awkwardness of those to whom we must delegate work which we can not do, costs us dearly every day. They bungle and blunder and delay us in an unlistable variety of ways. Our awkwardness works them the same hindrance. In this branch of the subject it would be tedious to enumerate, but fruitful to sit and think.

On the whole it is hard to say whether in our sustenance of the full measure of the life of our day we suffer most from the *existence*, or from the *wickedness*, or from the *awkwardness* of the other human beings who are trying to sustain life in the same planet, and have the same right to it as we.

Fortunately, they also help us, marvelously help us, and it remains to study how they help us. A more or less minute study of the ways in which our fellow-beings help us in making a living or achieving a sustenance, constitutes the main body of the science of political economy. Before entering on that study, it is well enough to inquire what we wish the result of their help to be. It needs not to be said that we are to help them as truly and if possible as fully as they do us. Keeping this tacitly in mind, what kind of a sustenance do we wish them to help us get? We think at once of two features which must characterize it: 1. We want it ample. 2. We want it easy.

In other words, we want as plenty as possible, and with as little work as possible. It is not merely plenty to eat and wear that we want, but in every other respect an ample living. Our tastes differ,

as well as our means, in amplitude. Perfection in amplitude of means few if any of us have; but we all want it, and, failing perfection, the nearest possible approach to it.

But we like ease, too, as well as abundance. We rate these two features of our sustenance at different relative values; some of us placing a higher value on ease and others on amplitude. Some, for the sake of ease, are willing to get along without things which others are willing to work hard for. This fact must never be forgotten, for it stands in the way of many very promising schemes. In personal contact, we may have no respect for the lazy man's laziness; but, as a scientific fact, we are bound to respect it or lose our reckoning.

Laziness is, in fact, a universal characteristic, and, when not excessive, a decidedly valuable one. Whoever lacked it entirely would soon work himself to death. Work wears us out. Laziness makes us decline to wear ourselves out with work unless we see hope of a reward which will rebuild us. It leads us to calculate closely the ratio of effort to satisfaction. The establishment of that ratio, at the point of minimum effort and maximum satisfaction, is the end and aim of all human forethought. This sometimes seems not to be true. Some persons seem to have a real appetite for work. But does such an appetite ever survive the hope of a return, either to that person or to another in whom he takes an interest? No work is done excepting to amplify the sustenance, to enlarge and complete the life of some human being, or to secure for that being rest hereafter. We may work on and postpone both ease and amplitude of living indefinitely, but we always keep them both in mind as our future reward. We may think to bestow the ease upon ourselves when we shall be too old to work, and in the mean time to work and earn it. This scheme is as wise as it is natural.

We may also forego in the present some pleasures or comforts which we might enjoy, for the sake of making our old age average well with the rest of our lives in these respects. It is a pity that human beings do not all behave in this way.

It may be hastily said that the laziness or extravagance of our fellow-beings *hinders* us in making a living. But just here a careful distinction must be made. It is one thing for them to hinder us, and essentially another thing for them to fail to help us as much as they might. It is this that the sluggard and the spendthrift both do. Supposing that each barely earns whatever living he has, the spendthrift helps us most, because no one can earn an ample sustenance, whatever he afterward does with it, without helping his fellow-beings. This rule is not necessarily universal, but it applies to all civilized countries and all times. If there are any communities where human beings make a living without the help of others, and without helping others, these communities are not subjects of economic study, except as serving to illustrate the economic by reference to the uneconomic.

This leads us to the grand truth of the science, which is that, *cæteris paribus*, the better living others make, the more they help us to make ours. Not the better living they *get*, but the better living they *make*. It is not necessary to express in terms the difference between getting and making a living. A pauper does not make his living, but he gets it, notwithstanding. The same is true of people who beat their creditors. We see the difference quite plainly here. Yet if we tried to define it so that we should never have to revise our definition, we should probably be led into one of those time-wasting and brain-wasting quibbles which have been the bane of political economy. All we need do is to emphasize the word "make," when we repeat, as we can not too often repeat, that the better living others make, the more they help us to make ours; and the better living we make, the more we help others to make theirs.

There is another correlative truth, sometimes crossing and sometimes paralleling this one, that the more carefully human beings husband their means, the more they help one another in acquiring means. A careful study of the nature of capital helps us to appreciate this truth. This is not the place to enter into that study. Suffice it here to say generally that others help us most when they work and save. They help us when they only work, and they help us when they only save, but they help us most when they both work and save. And we them in like manner.

Hence it is easier to make a living in an industrious, frugal community than in a lazy, thriftless one. Hence, also, the profit to the community of the labor of convicts, paupers, and other persons in state custody. Hence the great advantage of having the world's work so divided and arranged that the weak as well as the strong can find something to do.

One other general truth, with many important special applications, must be stated here. If those who do much work, and get and squander the full reward of their labor, help us much in making a living; and if those who do much work, and, getting a good reward, save a portion of it, help us still more; those help us still more who, doing much work, are content or forced by necessity to accept a small reward. It always pays to hire a man, or trade with a man, who, considering its real worth, puts a small value upon his labor, and is satisfied with a small reward for it. Such a man may be too generous for his own good, but not for the good of those who deal with him. For, of course, the extreme limit of help in making a living which anybody could afford us would be to make it for us out-and-out gratuitously.

Undue help may cause us to relax our efforts, or to make reckless use of our opportunities, so that in the end we may be worse off; but that does not make it any the less help. We may misuse any blessing we enjoy.

But we must remember all the time that the practical object of any

study of political economy or social sustenance must be, or should be, to promote the easy and ample sustenance of all, and not of some at the expense of others. Hence we desire that human helpfulness shall be not only effective but mutual. One-sided helpfulness is one of the chief evils for which we seek a remedy.

Yet we have to note carefully that the circumstance which makes our mutual help most effective may make it one-sided. We want a balance of mutual sustenance, while we help sustain one another, but we also want amplitude. We want each to have a *fair* share, but it may be that by some having more and some less than our estimate, or any estimate of a "fair" share, all will have a *larger* share. We should like it both fair and large. We can never have it either as fair or as large as we should like it. Some will always get more help than they give, and others give more than they get. And none will ever get as much as he wants.

We all agree that a proper balance of human helpfulness is desirable. We can not help agreeing that its amplitude is also desirable. The point whereon we may differ is the extent to which balance should be subordinated to amplitude, or amplitude to balance—that is, whether poverty with equality is better than wealth with inequality, the term "equality" signifying a share of sustenance to each in proportion to his services, be they much or little. So far as balance *begets* amplitude, we shall all agree theoretically, and be led by our greed to disagree practically. Each of us will always be so anxious to be sure of his share, that he will be willing to get a little more than his share.

And in this we shall always be subject to deception by appearances, as we are in all other matters. What seems to promise both abundance and equality may in practice work both impoverishment and inequality. Mastery of this deep and vital problem demands the exercise of every logical power at our command and the widest possible scope of vision.

ORIGIN OF COMETS AND METEORS.

By RICHARD A. PROCTOR.

THERE appeared in these pages not long since a valuable essay, by M. Daubrée, on the structure of meteorites, and a little later a very interesting paper by Professor Newton, of Yale College, in which the general question of the origin of meteors, meteorites, and comets was discussed, without any definite conclusion being indicated, except that there are objections against all the various opinions which have been expressed by Schiaparelli, Tschermak, Meunier, Daubrée, and others, respecting this very difficult subject. I should be glad if permission could be accorded to me to bring before the readers of a magazine, so high in scientific standing as "The Popular Science

Monthly," the theory to which my own researches have led me—the more so, that I find my ideas quite commonly misapprehended, insomuch that objections have been urged (as by Professor Newton and by my friend Professor Young) which, though, full of force in themselves, have no bearing whatsoever on my theory as it really is.

I may say, indeed, at the outset, that I am in thorough agreement with all or very nearly all which Professor Newton has urged in the way of objection against the views of those who have theorized on this subject on special lines, including the view (which he attributes to myself) that comets and meteors have been expelled from the sun, or from the giant planets. But, at the same time, I find in all those theories, including even the one mistakenly attributed to myself, the germs of truth. If Schiaparelli is quite mistaken in regarding comets as captured meteor-flights, we yet owe to Schiaparelli the now established theory, admitted by all (unless Mr. Denning can be counted as an exception), that meteors are closely connected with comets, and the probable theory that comets are in reality flights of meteors, though their origin in our system may not be that which Schiaparelli has assigned to them. Again, Tschermak is undoubtedly mistaken in supposing that meteorites were originally expelled from the earth's interior, yet the evidence which he has adduced to show that a certain class of meteoric bodies most probably had such an origin can not be lightly overlooked. In like manner when Daubrée speaks of meteorites as having had their origin in the stars, and regards all orders of them as telling us of stellar interiors, he unquestionably lays himself open to the objection that certain orders of meteoric bodies can not possibly have had that origin, their orbits being entirely inconsistent with any such supposition. Yet, in the work Daubrée has done to indicate the conditions under which meteorites were first formed, he has as unquestionably supplied material, of which the true theory, whatsoever it may be, must take account. So with the theory which I have been supposed to entertain. It is manifest that bodies shot forth from the sun would either return to him, or, if their velocities of ejection were great enough, would pass away not only from him, but from the solar system, forever. It is manifest, also, that the giant planets can not now possess power to expel bodies from their interior with such force as would be required for absolute rejection as distinguished from mere temporary ejection ; and certainly nothing in the present condition of our earth, or in the evidence given by her crust as to past volcanic action, suggests the likelihood, if even the possibility, that during her career as a planet she has had the power of rejecting matter from her interior.

But I have mostly found that, in endeavoring to form a true general theory on a subject of this kind, it is important to gather together the good features of the several special theories, not merely to note such weak features as become associated with them through a mis-

taken endeavor to make them parts of a general theory on the same scale in regard to details. A specialist, striving to generalize, nearly always goes more or less astray; but, instead of following him, even though with the idea of setting him right, it is best to take the special results he has obtained at the cost of much labor and research. If we do this with the work of all who have dealt specially with a subject, the chances are that we shall find we have gathered nearly enough to indicate a general theory, which shall include all these specially ascertained details. This the true theory, whatsoever it may be, should unquestionably do. My theory, at any rate, has been obtained in this way, and is intended in its wide generality to cover all the known facts.

So much premised, I note that my reasoning on the subject of comets and meteors starts from the idea which Professor Newton seems very properly to regard as almost necessarily true, that shooting-stars, fire-balls, aërolites, and in fine all orders of meteoric bodies, belong to the same general class, differing only *inter se* in size, distribution, orbital motion, and the proportions in which the materials constituting them are distributed. It appears to me, as it does to him, that a theory which will account for such streams as supply the August and November displays, but not for the meteoric masses which fall sporadically, can not be the true general theory of meteors; nor can any theory be accepted as at once true and general which accounts for the holosiderites while it leaves unexplained the asiderites (so called, though in reality no meteors are free from iron). Again, noting that meteors have been associated with comets, we require for any theory which shall be accepted as generally true, that while it shall explain this connection between streams of bodies producing falling stars and certain special comets, it shall also be able to account for *all* comets as possibly associated with meteor-streams, and for *all* meteor-streams as possibly associated with comets. How much resides in this last condition, those only can guess who have put the matter to the test by striving to find a general theory of comets and meteors which shall not be found to be in conflict with some fact known about particular comets or some other fact known about particular meteor systems. Yet no general theory of comets and meteors can possibly be accepted which fails when thus tested, trying though the test may be. These trying tests are, indeed, particularly valuable for the seeker after truth, seeing that they serve to diminish his field of research by fencing out portions which can not usefully be dealt with. My own experience has convinced me that negative indications serve often to lead more directly to the truth than the most seemingly decisive evidence of the positive sort, though in reality it is by combining the two kinds of evidence, rejecting because of decisive negative evidence theory after theory from among those to which we are directed by decisive positive evidence, that we can alone hope to arrive at the true theory.

With a wide choice as to a starting-point, I take first the results of M. Daubrée's analysis of meteorites in regard to chemical composition and physical structure; and I combine the positive evidence he has obtained with Professor Newton's argument—very just and of great negative weight—that no theory can reasonably be accepted with regard to meteorites which may not be extended in its general sense to all orders of meteoric bodies.

M. Daubrée tells us, then (nay, he shows by demonstrative experimental evidence), that meteorites resemble so closely in composition and structure volcanic products such as are only found deep below the earth's crust, that we may be assured they were formed under similar conditions of temperature and pressure. He constructs masses of matter under such conditions which the most experienced student of meteorites could not distinguish from true meteoric masses; and he points out how the earth in her interior laboratories has constructed and presently ejected bodies which in like manner deceived the most experienced, taking their place for a long time in museums as "the Ovifak meteorites."

M. Daubrée very naturally draws the inference that meteorites were actually formed under such conditions. But a mass formed as such volcanic products are being now formed, deep beneath the crust of the earth, could not possibly escape from such a birthplace except by such energetic extrusion as a body like our earth, now or during the ages recorded in the geologic strata, could not possibly have effected. Hence, M. Daubrée infers (again, quite naturally) that meteorites were ejected from the interiors of stars.

Applying to this result the principle indicated by Professor Newton, we see that it requires to be at once generalized and modified, for there are classes of meteoric bodies which can not possibly be regarded as coming from any of those orbs which we call stars. Among these may be specially mentioned, first, those orders of meteoric bodies which Stanislas Meunier and Tschermak have been led to regard as ejected from the earth. Without for the moment attaching any specific importance to this idea as involving a positive theory of the origin of these meteors, it is certain that the evidence adduced by Tschermak and Meunier, confirmed also by the mathematical inquiries of Sir Robert Ball, definitely negatives the idea of an origin outside the sun's special domain. In like manner we must exclude those meteor-streams which, like the Leonides, the Perseids, and the Bielids, travel in closed paths, indicating an origin within the solar system. I have myself adduced evidence which is really demonstrative, and admitted (even by those who think there *may* be some escape from it) to be for the present unanswerable, to show that these meteor-streams can not have been captured as meteor-flights by the giant planets, as Schiaparelli suggested. But, apart from this, I believe that no one who considers the nature of these streams, or the character of the or-

bits in which their components move, will for a moment adopt the belief that they have been ejected from the stars, even though he may accept the colorless theory (which explains nothing) that they were captured by the giant planets from out the star-depths.

Nor are we at all helped by remembering that the sun himself is a star, and that certain among the meteors which reach the earth may be supposed to have come from him. For assuredly the meteors regarded by Meunier and Tschermak as of terrestrial origin can not be attributed to the sun as their source, while the orbits of all the recognized meteor-streams are entirely inconsistent with such an origin. Mr. Matthew Williams, in his "Fuel of the Sun," has pictured bodies ejected from the sun which *somehow* come to be traveling afterward in orbits nowhere approaching within millions of miles of his surface; but no such processes are within the range of dynamical possibilities.

How, then, are we to retain at the same time what we regard as proved by Daubrée, and also those facts, inconsistent with Daubrée's theory as actually presented, which have been shown with equal certainty, either in their positive aspect (as in the case of the November and August meteor-streams) or negatively, to be certainly inconsistent with the supposed origin of meteorites from the stars? Clearly we must widen our range of survey so as to recognize an origin for meteors and meteorites which, while including Daubrée's facts, shall not exclude the others; and I think there can be very little doubt how such widening of the range of survey should be effected. Widening our survey of space will be of no service, for we only bring in more distant regions, and the meteors we have to explain require a nearer origin; but if we widen our survey of time, as assuredly we are justified in doing (for many meteorites must be millions, nay, tens, hundreds of millions of years old), we shall find other stars than those considered in Daubrée's theory, and some of these may meet our difficulty.

If there is one fact about the past of our earth and the other members of the solar system which may be regarded as certain (amid all our uncertainties in regard to the possible nebular origin of the system, or its possible origin by aggregation, or by a combination of both processes), it is that each planet began its career in a state of intense heat. I suppose no one doubts now that the giant planets retain much more of their primeval heat than the earth or Venus or Mars; nor, on the other hand, can it be reasonably doubted that the moon has parted with much more of her original heat than our earth, insomuch that, whereas, once she was the scene of such activities as we recognize in our world, she is now a cold and lifeless orb. It is in their aspect as records of the past of the planets that I note these facts. They indicate a progressive loss of heat which we only have to trace back to recognize each one of the planets, in the earliest stages of its career, as a sun-like body.

Extending, then, thus our survey in time, we find another set of

stars, or rather of suns (we must now use the more general word), to be added to those regarded by Daubrée as the bodies from which meteorites (and meteors of all classes, according to Professor Newton's just generalization) have proceeded. We may in one sense, indeed, be said to have multiplied Daubrée's sun-sources of meteors manifold, since for every sun now existing in space our views as extended show a whole family of sun-like orbs. But in reality we have only strengthened our theory by the addition of the suns which once belonged to our present sun's domain, for these alone could in any way explain the meteors and meteor-streams which had prevented us from accepting stellar (or rather extra-planetary) origin for meteoric bodies. It is to be observed, however, that these suns which we now introduce into the theory were not all active at the same time. We must regard them as distributed in time much as the stars are distributed in space—some very far off, others far off, indeed, but yet *comparatively* near; and in determining the distance of time at which they were active as suns, we can not range them in any definite order according to their mass. For instance, our own earth, though much more advanced in planetary life—that is, far cooler—than a giant planet like Jupiter, was probably in an actively sun-like state at a much more recent time: since the interval of time during which Jupiter has been cooling from the sun-like stage to his present fiery condition enormously exceeded, in all probability (owing to the vastness of his mass), the time occupied by the earth in passing from the sun-like stage through the fiery stage to her present cool and habitable condition; and, on the other hand, though Mars is much more advanced in planetary life than the earth, yet it is quite possible (though we can form no definite opinion in this case as in the former) that Mars might have been in the sun-like stage later than the earth.

We may observe here that we not only remove from Daubrée's theory, by this extension of it, the difficulties which had before prevented us from accepting it as a general theory of the origin of meteors, but we place the theories suggested by Tschermak, Meunier, Schiaparelli, and others, in a much more satisfactory light than before. It is properly objected to Tschermak's theory, by Professor Newton and others, that our earth can not be supposed to have ever had while a world explosive energy such as that theory imagines; but when the earth was in the sun-like state she could do all that might befit a sun. We know that our sun can eject matter from his interior with velocities sufficing to carry such matter forever away from him, for he has been caught, first by Professor Young in 1872, and several times since, in the act. What our sun with his much vaster energies can do ejectively to overcome the withdrawing power of his own much mightier mass, we may well believe that our earth in *her* sun-like days could do to overcome the attraction of her smaller mass. The only difference would be that while the sun on such occasions expels matter so as to

pass forever away not only from himself but from the solar system, the earth, even in the full energy of her sun-like condition, could not probably have expelled bodies from her interior with velocity sufficing to carry them beyond the control of the sun.* The bodies ejected with velocities freeing them from the earth would thenceforward travel around the sun on orbits of different dimensions within certain limits.† Their orbits would at first intersect the earth's path, and, even under the perturbing actions of the planets, would always pass very near it, oscillating, in this respect, on either side of the earth's track so as at intervals to cross it for a while as at first. Hence there would always remain a chance of recapture, and indeed there would be a certainty that, in the fullness of time, every body ejected from the earth would be recaptured, though the fullness of time might in some cases mean many millions of years. Thus the capture of sporadic meteors of terrestrial origin would be fully accounted for.

In like manner with those streams of meteors whose orbits lie within the solar system so as to preclude the supposition that these bodies could have reached the system from without. I say definitely that the supposition is precluded, because the argument from the consideration of the laws of motion, by which I have shown that the giant planets could not possibly have captured these meteor-streams in the manner imagined by Schiaparelli, is admitted to be sound even by those who have not weighed my own theory in explanation of the origin of these systems. It is suggested by some, as by Professor Young, that there *may be some* way of explaining away the difficulty I have indicated; but I am not prepared to regard a vague suggestion of this kind as having any present weight. It seems, to say the truth, much as though one should say, for example, It has indeed been demonstrated mathematically that the circumference of a circle is not arithmetically commensurable with the diameter, but there *may* be

* It would not be absolutely impossible that some of the matter ejected from the earth in this way would pass away even from the solar system. It appears from the very existence of earth-ejected meteors, which we regard as demonstrated by Tschermak and Meunier, that she had power of ejecting matter with velocities up to seven miles per second. A velocity of little more than eight miles per second would suffice to carry matter away from the solar system if the matter chanced to be ejected from the middle of the advancing face of the earth, for then there would result *relatively to the sun* a velocity of more than twenty-six miles per second, which at the earth's distance is a velocity corresponding to parabolic motion around the sun; but this would very rarely happen.

† If we suppose our earth's eruptive power to be unable to give greater velocity of ejection than eight miles per second, then the velocities of bodies expelled from the earth would, at the distance from the sun where they began their independent careers, range between twenty-six miles and ten miles per second, the earth's orbital velocity being eighteen miles per second. Hence the orbits of the expelled bodies around the sun would range between parabolic orbits with perihelia at the earth's distance, and ellipitical orbits with aphelia at the earth's distance and perihelia at a distance of one third the earth's, with an eccentricity of ·866. None of the expelled bodies could come nearer to the sun than this last-named perihelion distance.

some way of representing the ratio of the circumference of a circle to the diameter as a fraction of some sort. The fact remains that this has been proved to be impossible; and it has equally been shown to be impossible that any flight of meteors could be captured (that is, brought into the solar domain for good) *as such*, by any planet, even by the giant Jupiter. Either the meteors must lie so very close together that their mutual attractions would make them practically one body, and keep them such after capture by the planet, which is not the case with any of the meteor-streams, or else the differences of perturbing action on the meteors would be so great that the flight must be entirely dispersed in the act of capture—not merely dispersed so as to form a stream or a larger flight, but so dispersed as no longer to form a meteor system at all.

But, extending our generalized theory to the case of the giant planets—as, be it observed, we are not only entitled but bound to do—we see that as there would be flights of meteors passing always near the earth's orbit because of their original derivation from the earth in her sun-like stage, so would there be flights of meteors passing always near the orbit of each one of the giant planets; unless, indeed, in the fullness of the vast periods of time which must have elapsed since their formation, processes such as seem to affect Encke's comet should have altered their orbits considerably. Even then they would exhibit an approach to the orbits of their parent planets such as to suggest the idea of some sort of physical association. And accordingly, we find this peculiarity so far manifested, that years before the idea ever occurred to me that any comets or meteor systems could have been expelled from the giant planets, I wrote an essay on what I called the "Comet Families of the Giant Planets," describing just such comets, though I was unable to find any interpretation at that time of the peculiarity in question.

It is worthy of notice that quite a number of difficulties, some of them very serious ones, disappear, even as these last two have done, so soon as we adopt this generalization of the special theory to which we found ourselves forced first by direct evidence.

For example, if the capture theory advanced by Schiaparelli were accepted, not only would it leave all our perplexities unexplained, not only would it involve our running directly against mathematical certainties, but it would introduce this tremendous difficulty: the number of meteor-flights traveling about in interstellar space must exceed many millions of times those which visit our solar system, and the number of such flights visiting our solar system must exceed millions of millions of times those which chanced, by a strange combination of accidents, to come within capturing distance of a planet. Again, if many of the meteor systems which cross our earth's orbit are not to be attributed to a terrestrial origin, then the number of meteor systems within the solar domain must exceed millions of millions of millions

of times those which have thus been recognized. In the former case the capturing-places in the solar system are very limited in extent compared with the dimensions of the system; but in the latter case it is the whole domain of the sun which we have to compare with that mere thread of space traversed by our earth within the solar system.

I might have arrived at the same result, however, in entirely different ways—a consideration which is at once the most marked characteristic and the surest test of truth in a general theory of this sort.

Suppose, for instance, I had begun with the discovery by Professor Young that the sun has tremendous ejective might. I have shown, from the circumstances attending the formation of the eruptive prominences, that they do not indicate the ejection of glowing hydrogen and helium, but of small masses of denser matter *through* those gases. (I note, in passing, that Tacchini's observations during the last eclipse have practically demonstrated the justice of this view.) I have further proved that such masses of ejected matter have in some cases had velocities exceeding the three hundred and eighty-two miles per second which the sun can master, and therefore must have passed forever away from him. From this demonstrated fact, as surely as from M. Daubrée's demonstrated facts about meteorites, we can work out the whole theory of cometic and meteoric ejection. For our sun, being one of the stars, we may infer that what he does each star also does. Again, what he does now he must have done (perhaps once with even greater energy) during all the millions of years that he has been a sun and doing sun-work. So also must all the suns which people space, during the past millions of years of their sun-work, have expelled from time to time flights of small bodies (whose nature we have yet, so far as *this* discussion of our theory is concerned, to determine). We may conclude that from the total matter ejected at any outburst many millions of small bodies would be formed as the originally vaporous matter vomited forth condensed into the liquid form and then into the solid—perhaps quite close to the parent orb. But the total mass ejected would bear to the ejecting body some such relation as the total mass of the dust ejected at Krakatoa bore to the six hundred millions of millions of millions of tons of the earth's mass; a hundred millions of years of such ejective work from an orb like our sun might well be unable to eject a total mass from out of which such a globe as even the least of the asteroids could be formed. Moreover, what we have thus inferred about each sun during the whole of its career up to the present time, we must infer also of each one of the bodies attending on each of those suns, during the sun-like portion of the career of each such attendant orb.

Hence, taking an average meteor-flight to represent the number of bodies at each ejection, ten effective ejections per annum for each sun-like orb, an average of a million years only for the sun-like duration of each orb in space, a thousand millions of suns in our galaxy

(a three-inch telescope shows a million stars), and ten orbs of various size depending (on the average) on each, then we have a grand total of $10 \times 1{,}000{,}000 \times 1{,}000{,}000{,}000 \times 10 = 100{,}000$ millions of millions of meteor flights, as representing the total number of bodies ejected from the various orbs peopling space, including those now sun-like, and also those which, though now in the fiery stage, or further advanced still in planetary life, were once as surely suns as the stars are now.

When we remember that with so many millions of millions of flights of bodies, each flight to be counted probably by millions of millions, our earth *must* from time to time be saluted by some of these, while we know that during all the years over which observation has continued, absolutely nothing has reached our earth from outside except the various orders of meteors, while no flights of bodies can be recognized as ever visiting us from interplanetary space except the various orders of comets, we are justified in concluding that *these* represent products of ejection. We infer this on the safe ground of the argument that if these bodies do not, no other bodies exist which *can* represent the product of the ejective processes we have certainly recognized. It would have been a rather bold thought, yet not wanting in reasonableness, and certainly ingenious, to have said that *therefore* comets and meteors are but different appearances of the same objects. This, though it might have been shown to be probable, could not have been shown to be certain; for the simple reason that the ejected bodies might have been only discernible when any of them entered our atmosphere, in which case only meteors would have been required by the facts or accounted for by the theory of ejection. But now that we know comets to be but flights of meteors, and meteors to be but attendants on comets, we see that one of the prettiest discoveries of modern astronomy, Schiaparelli's recognition of the connection between comets and meteors,* is implicitly associated with the results of inquiry applied to the sun's power of volcanic ejection. We might further have inferred the discoveries of Tschermak, Daubrée, Sorby, Graham, and others, as to the structure of meteorites, even though none of these bodies had ever reached our earth from interplanetary space—seeing that our earth's interior, beneath the regions now relieved by volcanic outbursts, would afford good information as to the nature of bodies ejected from such deep-seated regions of her interior, or of the interior of other celestial orbs.

A theory which could not be true except in its most generalized form, but which in that form (1) agrees with every one of the known facts, (2) accounts for many of them, (3) alone accounts for some of

* I take some pleasure in noting that I was the original proposer, and an intimate friend of mine the seconder, of the proposition that the Council of the Astronomical Society should bestow their gold medal on Signor Schiaparelli for this discovery. If we must have the prize-pig system of rewarding scientific research, let us at least, according to the good old English saying, "catch the right pig by the tail."

them, (4) shows that certain of them are its necessary consequences, would probably be right, even though it had not been yet shown that among all other possible theories there is not one which is not directly contradicted by some known facts. As, however, the general theory of the ejection of all cometic and meteoric bodies from orbs—suns of all orders, giant planets, terrestrial planets, planetoids, and moons—is as strongly supported by such negative evidence as it is by direct positive evidence, I venture to say that a case not easily shaken has been made out in its favor. No one, so far as I know, has yet indicated any objection against the theory in the generalized form in which alone I have ever advanced it. Objections have been urged against it in the form in which it has been supposed that I have maintained it. It has been very clearly shown that meteors can not come to the earth from the sun unless they strike the earth on their first course out from the central orb; it has been proved that a considerable proportion of the meteoric and cometic systems known can not have had their origin either in our sun or in any of his fellow-suns, the stars; it has been urged as effectively that the giant planets can not eject comets or meteors; and it has been shown clearly that our earth can not, in any stage of which geology has traced the records, have ejected bodies which could thenceforth travel in interplanetary space as meteors or meteor-flights. But, in these objections against specific theories of the possible origin of comets and meteors, we may find some of the strongest, if not the very strongest, arguments for that general theory to which each specific theory points, so soon as we notice that the arguments supporting each specific theory are such as decline to be limited to that theory alone.

In fine, as I suggested at the outset, if we apply to the several specific theories of comets and meteors the general principles laid down by Professor Newton, we find ourselves led irresistibly to that general theory which I have sketched above, and presented with more elaboration of detail elsewhere.

INFLUENCE OF SNOW-MASSES ON CLIMATE.

By M. A. J. WOEIKOFF.

THE masses of snow and ice known as glaciers, which are found upon high mountains, have been the object of many studies; and it is a matter to be wondered at that the same has not been the case with the immense beds of snow that every winter cover parts of Europe, Asia, and America, to disappear in the following spring. It has perhaps been thought that the latter have less influence upon climate in general than upon other more special phenomena. But the observations that follow will tend to show that this influence exists and the subject is one well worthy to be studied.

A bed of snow covering the ground acts as a bad conductor, and renders the exchange of temperature between the surface of the ground and the lower stratum of the atmosphere slower than it would be if the snow were absent. This is a result of the porous structure of snow, the interspaces of which are filled with air. In this matter the condition of the snow is of considerable importance; the minute crystals formed by cold are poorer conductors than the larger flakes; but if the snow by alternately thawing and freezing assumes the form called *névé*, it becomes a much better conductor of heat. Farmers in countries that enjoy cold winters are well aware of the protective nature of the snow-covering, and do not fear for their grain when it is thick.

The presence of snow thus assures a higher temperature to the upper layer of the soil than it would otherwise have, and its thickness is an equally important factor with its structure. But its effect on the air is different, for it separates the air from the warmth which without its presence would escape from the ground. Snow also exercises an important influence through its power of radiation, which is dependent on its whiteness and the extent of its surface, but in which thickness is not a factor.

When air is rarefied, it contains, besides the vapor of water, only a few scattering particles of dust or smoke. Even in the tropics, snow on high mountains does not melt. Although a considerable amount of solar heat is received by the upper surface of the snow, it is all sent back into space, and the air, being very diathermanous, only retains a very small part of it. In the plain countries of high latitudes the air is not rarefied, but, when there is a large extent of snow, the other conditions are similar to those which prevail at great elevations under the tropics, particularly the absence of dust and the small quantity of aqueous vapor. The latter condition is the result of cold, while the former may arise from the fact that there is no dry bare ground near from which dust can be swept up, or from the more or less complete absence of organic life. In this case as in that of high mountains, radiation into space goes on freely, and the solar rays are without power to melt the snow so long as it preserves its light structure, and its surface does not present any dark object to absorb the rays of the sun and cause the snow around it to melt. Thus, we observe that it melts on roofs and immediately around trees, while the clear snow in the vicinity shows no signs of thawing. Snow will melt rapidly under a piece of brown paper lying in a garden; and a thin sprinkling of dust on top of snow will produce a similar effect.

We conclude, from these observations, that if a large extent of continent is covered with snow, that snow will not melt under the rays of the sun. Yet we know that the winter snows in Northern Europe, Asia, and America melt every spring and summer. How does this come about? Observations made in high latitudes show that the

temperature generally remains below the point of congelation till the middle of June—that is, till a time when these latitudes receive daily a much more considerable quantity of solar heat than is received at the equator; and that frosts last there for a month or six weeks during which the sun never sets. Besides this, the solar rays are seldom intercepted by clouds, for the month of May is usually very clear in the northern regions. At Polaris Bay, latitude 81° 86′, in Northern Greenland, the sun does not set after the 11th of April, and yet, in 1872, on the 1st of June, the temperature of the air had not risen beyond the freezing-point except for ten hours on the 21st of May, while after the 2d of June the temperature was constantly above 32°; and the days during April and May were generally clear. The United States Expedition under Captain Hall passed the winter at Polaris House, latitude 78° 23′, where the sun did not set after the 20th of April. Here, again, there was no general thaw before the 31st of May, but only partial thaws on the 16th, 22d, and 27th, although the days were quite clear. On the 8th of May the sky was wholly clear for several hours, before and after noon, and the temperature was —14·4° C. at noon, and —15·1 at three o'clock in the afternoon. It was also perfectly clear on the 31st, at six o'clock in the morning and six o'clock in the evening, and the temperature did not rise above —8·8°. The observations of the Vega at Pitlekaj, near Behring Strait, in a much lower latitude, gave analogous results. We therefore see that in high northern latitudes the heat of the rays of the sun at the end of spring and the beginning of summer can not raise the temperature above the freezing-point. To what, then, shall we attribute the thaw? Probably to the winds that have passed over warmer countries, over continents, or open seas. According to the observations of the Vega, the winds came from the north till the 12th of June, and then, on the 13th, passed around to the south-southeast. These warm winds melt the upper layer of the snow; when it freezes again, it changes into *névé*, or takes on a condition less diathermanous to solar heat, in which it less readily sends back the warmth which it receives.

The melting of the snow may be speeded by the dust which the wind brings from the continental spaces whence it has already disappeared. If the warm winds do not last long enough and are not strong enough, they will not produce durable results; but a new fall of snow will give a new layer, which is only slightly diathermanous, and possesses great radiating power. As a large quantity of caloric is expended in the melting of snow, the warm winds lose much of their heat, and may thereby produce a considerable refrigerant effect. But along the frontiers of the region covered by snow, the surface of the ground, after that is nearly melted, may be warmed by the sun, and thus become a source of heat to countries farther north. The movement begins along seas that never freeze and continental spaces in which the snow never, even in winter, forms a permanent bed; it then

advances more and more northward, till all the low lands of our hemisphere are (so far as we know) freed from their covering.

This advance is not continuous, but proceeds, as we might say, by leaps and bounds. Warm winds coming from the south, or from the sea, further it, but cold winds arrest it, and sometimes reduce the temperature, where the thaw has already begun, to below the freezing-point. The disappearance of the snow in all the plains of the northern hemisphere is due to the geographical conditions of the hemisphere, or because all its known parts are reached by warm, melting winds. Moreover, in some countries in high latitudes but little snow falls, so that there is not much to melt. This, however, is not always the case, for snow may be seen to cover the ground, and the temperature of the freezing-point to prevail even during the summer. The fact is not only possible, but is a reality in very high northern latitudes. We learn from observations by Sir James Ross, that on the shores of the Antarctic lands the mean temperature, even in the height of summer, is considerably below the freezing-point, and never rises above it. This is explained by geographical conditions. The shores in question are at least 20° away from all other land, and can be influenced only by the seas north of them, while it has been observed that the temperature of these seas, down to 68° of south latitude remains below the freezing-point all through the summer. The Antarctic lands, therefore, do not receive from any quarter winds which can cause a thawing of the snow; and as this remains during the summer, the rays of the sun, notwithstanding its greater nearness to the earth at that time, can not raise the temperature above this point.

The existence of a very extensive bed of snow produces another important effect which has not received the attention it deserves: it keeps the temperature at but a little distance from the freezing-point, and below it. The mean temperature in February is the same at Bogoslowsk, at the eastern base of the Ural Mountains, and at Barnaul, on the upper Obi, at the foot of the Altai Mountains. But toward the southwest, not far from the Altais, in the Kirghiz steppes, there is usually but little snow. The mean and maximum of February are therefore higher. The same difference is observed between Ustsinolsk, in the government of Vologda, and Irgirs, in the Kirghiz steppes; and analogous differences may be remarked in other places. Wherever the snow-bed is less regular, the mean and extreme maxima of temperature are higher; and the difference goes on augmenting toward the south. It is especially considerable between Mitau, near the Baltic, and Nukurs, on the lower Amou (Oxus). In February the mean temperatures of these places differ by only 0·7° C., but the mean maximum is 10·2° and the absolute maximum 11·7°. The last result is all the more striking, for it is deduced from only six years of observations, while the observations at Mitau include a space of more than forty years. An analogous result is presented in De-

cember, when the monthly means and the mean minima differ very little, but the mean maxima of Nukurs are higher by 7° and the absolute maxima by more than 10°. This is because snow rarely falls at Nukurs, and a covering lasting for several days seldom occurs. In the absence of snow there is nothing to interfere with the action of warm winds, and, in that latitude, the sun heats the ground sensibly, even in the middle of winter.

The influence of a bed of snow on the maxima should vary according as the temperature is below or above the freezing-point. In the latter case, the melting of the snow, involving the absorption of heat, would tend to prevent increase of temperature. Not only does it prevent high maxima, but it keeps the temperature near the freezing-point long after it has begun. This is why April is colder than October in Russia, Central Europe, Canada, and the Northern United States. Farther north, for the same cause, the mean temperature of May is below that of September. It can not be doubted that this cause of cold, or rather this conversion of heat into melting action, is proportional, all other things being equal, to the mass of snow that remains on the ground. Hence, in countries having cold winters, the principal obstacle to the rise of temperature in spring is found in the quantity of snow on the ground, and not in the previous cold of the winter. It is only in countries situated near the sea, or in the neighborhood of large frozen lakes, that the mean temperature of the winter has much influence on the depression of temperature in the following spring and summer, because a larger quantity of ice is found in such situations during cold seasons, and a greater sum of heat is necessary to make the melting complete than in average seasons. Snow is the only cause that can produce an analogous result in countries distant from seas and lakes. It may be concluded, from the observations on these subjects, that, at the moment when the mean temperature begins to rise above the freezing-point, everything depends upon the sum of cold existing in the form of snow and ice. The greater it is, the slower and more irregular will be the rise of temperature.

The time of the coming of the snow, its depth, and its extent, have also a very great influence on the beginning and duration of the winter frosts; and this influence is manifested, not only in the particular spot, but—in the northern hemisphere—far to the south of it. In short, we may say that snow gives duration to the cold, and prevents a rapid rise of temperature. If we knew the exact moment when a bed of snow was formed in the North in fall and winter, and if we could announce it by telegraph, we might predict the time of the freezing of rivers and canals, and thus serve the interests of vast territories—as of most of Asiatic and European Russia, Scandinavia, British America, and the United States. The announcement of the closing of rivers by ice, even if it were only four or five days in advance, would prevent the considerable losses caused by premature

frosts, and permit the safe continuance of navigation during tardy winters.

In all countries where the snow forms deep masses in winter, the rivers rise at the time of its melting; the quantity of water produced by the melting of snow and ice is so great, and the evaporation is so little, as to produce much greater floods than ever can arise from rains. This phenomenon is therefore of a character to affect some of the sides of practical life; yet the way in which it operates has never been sufficiently well observed. The results of the thaw depend upon its rapidity as well as upon the quantity of snow that may be upon the ground when the frost breaks up. If the snow melts rapidly, inundations may ensue, while the duration of the high water will be too brief for it to be utilized for navigation; and the contrary will take place if the thaw is slow and gradual.

It is a popular saying in Russia that when there is little snow the waters will be high, and there will be little water when much snow falls. This kind of paradox is justified in the case of the smaller rivers. When little snow falls in winter, the ground freezes to a great depth. The first water that is spread over the surface also freezes, and a crust of ice is formed, over which the water flows as over a rock, without penetrating it. It therefore reaches the rivers quickly and swells their waters. When, on the contrary, the snow is abundant, it protects the ground in such a way that the thaw can begin from below, and the formation of a crust of ice on the surface is not possible. The melted snow penetrates the soil, and does not reach the ravines and rivers till after some time—that is, till after the ground has been saturated. The Russian peasants call this ground-water. Observation teaches that it proceeds from the forests rather than from the fields, because the snow accumulates there to a greater depth, and is less scattered by the winds than in open places.

The melting of snow from below was observed in 1884, at the Agricultural Academy of Petrovsky, near Moscow. Observations were made at the surface and at various depths down to two metres. At seventy-five centimetres the temperature reached the freezing-point on the 5th of March, and it rose to a greater height sooner from this point than at fifty or at twenty-five centimetres. As similar conditions have been observed at various points in the valley of the Volga, the high waters of that river in 1884 did not rise above the mean, notwithstanding the great depth of the snow; but the sources of the stream were so well supplied with water by the gradual melting of the snow that navigation was unimpeded during the whole of the summer and fall. The contrary took place in 1880, when a colder winter with less snow was favorable to a rapid thaw; the freshets were among the highest that had been observed, but the water soon fell off, and from August till October navigation everywhere above the mouth of the Kama was precarious.

Everything relating to the covering of the ground by snow is of such importance to science and practical life that it should be observed and published in detail. The exact moment when it occurs should be ascertained; the structure of the covering in different parts of the cold season; its depth in different places—in forests, parks, fields, and ravines; the time when it begins to melt; the advance of the thaw; the condition of the upper layer of soil under the snow (that is, whether an icy crust is formed and when), and the facts respecting high water in the rivers, should all be looked after. The business of making these observations could be intrusted to students of meteorological and phenological phenomena. The only point to be regarded as difficult is the observation of the depth of the snow under different conditions. This could be facilitated by having stakes fixed in advance, with white and red divisions clearly marked, so as to be visible from a distance. The most exact data on the mean depth of the snow will be furnished by forests, gardens, and parks, where the snow is protected against the wind by trees. In open places, numerous observations will be necessary, in consequence of the variations in the thickness of the snow, caused by the action of the wind. I believe, however, that a good observer would soon become at home, and find great interest in observations of this kind. After they have been continued systematically for a suitable time, and it has become possible to draw a few general deductions from them, telegrams might be dispatched to the central meteorological stations, reporting upon the condition of the snow. From these reports, important practical conclusions could be drawn, as in determining how long the rivers are likely to continue open to navigation, the amount of water that the rivers will have to carry after the thaw, and the probable character of the spring.

The snow-fall in the Himalayas has given rise to predictions respecting the arrival and conditions of spring in the north of India, which have been fully justified; and careful observations of this kind might be made very useful in other countries where the winters are liable to be severe. — *Translated for the Popular Science Monthly from Ciel et Terre.*

Dr. Martineau, by way of showing up the absurdity of using what may be called "unreal words" on religious subjects, has warned the evangelicals that they can not really believe in the damnation of persons with whom they dine and joke on cordial terms; and that, if they profess to do so, the sincerity of their belief or the cordiality of their social relations must suffer. The London "Spectator" hints that it is such "unreal words," too profusely uttered by those who profess to speak with the authority of revelation, that form the best justification for the unreal words uttered by those who believe in no such authority at all.

HYGIENE AS A BASIS OF MORALS.*

By FRANCES EMILY WHITE, M. D.,

PROFESSOR OF PHYSIOLOGY AND HYGIENE IN THE WOMAN'S MEDICAL COLLEGE OF PENNSYLVANIA.

IN the philosophy of Fichte, that prince among German idealists, the universe of matter, so called, is reduced to ideas, and that by a method of reasoning which the ablest opponents of idealism find it difficult to refute. This, doubtless, Fichte could easily arrange, so long as his brain, digestive apparatus, etc., were in good working condition; but let a congestion of the organ of mind or of its meninges set in, and what becomes of Fichte's ideas?

Sensibility (by which it is meant to indicate the whole mental life, from mere consciousness to the profoundest thinking) is never manifested (so far as known) apart from a certain mechanism, the living body; and while the universe may, in the last analysis, be reduced to matter and force, these two can not be divorced—not even by a Fichte. Since, therefore, the human body is admitted to be an integrant part of the universe of matter, its various activities must be included in the general category of forces. If, then, it be conceded that the body and mind of man hold to each other the same relations which exist between other aggregations of matter and their associated energies, the physician, though he minister to the body only, becomes thereby the high-priest of humanity, contributing to its noblest ends.

But in the parting words which it is my privilege to address to you (upon whom has just been conferred the responsible and honored title of Doctor of Medicine), I desire to point out a yet more excellent way in the pursuit of which you may indeed become the benefactors of mankind. The art of exterminating disease does not exist; and, although the death-rate varies in different localities and in the same locality under varying conditions, so far as recorded, no disease, once originated, has ever wholly disappeared; and while we may take a justifiable satisfaction in the advances made in the rational treatment of the sufferer from disease, the sources of disease (except so far as bacteriology gives promise in this direction) have not been disturbed, either by the progress in general civilization or by the great development of medical science and art. Both the experience of the past and modern scientific observation, then, alike point—not in the direction of the extirpation or even of the cure of actual disease—but rather in that of *preventive medicine or hygiene* as presenting the most hopeful field for future work. Not that I would undervalue the efforts of the profession toward the relief of suffering when disease actually exists—a most important and beneficent part of its work—but, just as exer-

* Address delivered at the thirty-fifth annual commencement.

tions for the release of an unfortunate inmate of Moyamensing are of less significance than the institution of measures calculated to reduce the number of commitments, so the application of means for the prevention of disease is of far higher value than effort in the direction of mere relief.

It is not, however, with the view of the prevention of physical suffering alone that I desire to commend to you the sphere of preventive medicine. My main thesis introduces us to a far higher and broader region of thought—viz., to a consideration of the *moral* value of preventive medicine. In presenting this subject I shall endeavor to show that hygiene is the *basis of morals,* and this from the two following points of view: 1. That whatever promotes the physical well-being of the individual and of the community, promotes also their moral well-being. 2. That the tendency of disease is to undermine morality.

The hygienic value of moral living (a proposition the exact converse of that just stated) has long been recognized. Even its curative influence has not been overlooked. In that charming story, "Little Lord Fauntleroy," the author is true to the universal experience in depicting the improvement in health of the unfeeling old earl which follows upon the springing up in his heart of a true affection for his young grandson and heir. In this new unfolding of sympathetic interests, he gradually forgets the twinges of gout which have heretofore made life a burden; and, thus neglected, the disease languishes —or rather, the new tide of life which courses through his weakened veins gradually sweeps away the ashes which have accumulated around his miserable joints—and he again mounts his horse and rides forth into the life-renewing air and sunshine, tempted to the effort by the winning companionship of the loving and tender-hearted young philanthropist. The returns of moral well-doing in the guise of physical well-being have, indeed, ever been held up as an incentive to morality, from that remote time when length of days was promised as the reward of filial piety, to those modern exhortations to honesty and virtue embodied in the mercenary maxims of the shrewd Ben Franklin. But the idea that hygienic living is the real basis of moral living has scarcely been hinted at, except by the few leaders in this department of thought among whom alone a science of morals is definitely recognized.

It would be idle to claim that society can be regenerated by a scientific formula, however profound; but, if the future progress of the race can be said to depend on the application of any one principle —if the field of rational effort toward this end may be illuminated by any one conception—it is this one of the dependence of morality upon the observance, both public and private, of the principles of health. This claim (which may be regarded by some as a fanciful one) is based upon the penetrating character and universal applicability of

the principle—penetrating and universal, because founded in the very laws of our being.

It will scarcely be denied that the most highly civilized races and nations are also, on the whole, the most distinguished for morality, and that the stage of progress of a people at any given period may be fairly estimated by the character of the moral code then prevailing. This is so well understood that illustration is unnecessary. It then follows that the development of morality is inseparable from the general progress. But the degree of civilization of a people at any given stage is determined by the nature of its environment—i. e., by the conditions under whose influence the nation has developed. It has been pointed out by a distinguished philosopher in literature and art, Professor Taine, that "the profound differences which exist between the German races on the one hand, and the Greeks and Latins on the other, have arisen, for the most part, from the differences between the countries in which they are settled"—for social conditions are determined primarily by organic or bodily conditions—these, in turn, depending on the physical environment. Thus, the general sources of organic life must be recognized as the sources also of morals; and the emotional, intellectual, and moral nature of man as an integrant part of his physical organism: being such, these higher qualities are necessarily modified by the conditions which influence and modify the physical organism.

A distinguished English sanitarian, Mr. Edwin Chadwick, has said that he could build a city which would give any desired death-rate from fifty or any number higher than fifty, to five or perhaps even less than five in a thousand, annually; and the President of the Health Department of the British Social Science Association, at the annual meeting in 1875, expressed his unqualified confidence in the feasibility of Mr. Chadwick's proposition. This means nothing less than that the death-rate, within these wide limits, from five or less to fifty or more per thousand annually, depends on the degree of attention paid to certain public sanitary regulations.

Side by side with this proposition, I venture (and with a degree of confidence not less than that of Mr. Chadwick) to place another proposition far more radical than his, viz., that a city might be so built, and the municipality so administered, as to secure *any desired degree of morality* within certain limits. That these limits can not, at present, be as exactly defined as in the case of the death-rate, results from the lack of systematic study of the subject of morals, and the consequent want of complete statistics in this department of sociology. The nature of the limits may, however, be designated; and I beg to illustrate this point by reference to the principles of animal development, of which it has been said, by Professor Du Bois-Reymond, that "the laws of organic structure must account for whatever, in organisms, is either useless or actually disadvantageous"—natural selection account-

ing for whatever is positively useful. In other words, two principles are recognized as determining the character of animal forms: 1. Natural selection, which implies the production of such structures as are useful in the particular environments in which the animal is placed. 2. The influence of the structure already acquired at any given period of development—this being determined by heredity. But heredity itself represents the organized product of a permanent environment, as illustrated, for example, in the hereditary blindness of fishes living in Mammoth Cave; or, better still, in the respiratory mechanism of all water-breathing animals; so that the environment is the ultimate factor which determines the specific character of animal forms—the structure developing slowly in accordance with this influence.

Similarly in the department of morals, two factors must be recognized as determining conduct: 1. Those qualities of character belonging by inheritance to the organized structure of body and brain. 2. Those influences which grow out of the social environment, which are constantly modifying the inherited nature, and building up a corresponding character. In my proposition, then, to found a city in which any given degree of morality, within certain limits, may be secured, these limits are understood to depend on the laws of inherited character; while the modifiable morality (that which may or may not be secured at the option of the founder of the city) is that which depends on the particular environment, physical and social, determined upon by the founder; the inherited character, also, like the inherited bodily organism, being subject to modification from this source. To discuss this proposition in a manner commensurate with its importance, would take us too far afield for the present occasion, since it would involve a consideration of the whole subject of the origin and evolution of morals. Your attention is, therefore, invited to a few only, and those the more obvious, points connected with this proposition of securing a given morality-rate within certain limits, inherently as definable, although not as precisely defined, as in the case of the proposition with reference to the mortality-rate.

As a result of Mr. Chadwick's statement, Dr. B. W. Richardson (in the address referred to) projected a city of health, which he named Hygeia (and which it is scarcely necessary to premise was located in Spain!) in which all the modern sanitary inventions and precautions, calculated either to promote health or to prevent disease, were grouped together in a picture most delightful to the mind's eye of every sanitarian. This model city, Hygeia, with some alterations and additions, would furnish the material substratum of the possible city of which I have spoken, and which I would name *Ethica*. A brief glance at the general features of our model will serve to bring the subject fairly before us.

First, and most conspicuously, we note that overcrowding in this city of health is impossible—made so by the style and location of the

houses, which secure an equal distribution of the population fixed, at the time of building, at one hundred thousand people, domiciled in twenty thousand houses, which are scattered over an area of four thousand acres. Crowded alleys in the immediate rear of streets lined with spacious dwellings are wholly avoided; neither are tall structures, overshadowing the streets (a veritable shadow of death), anywhere permitted, four stories, aggregating sixty feet in height, being the limit with which all must comply. Every house has its foundations on solid arches of brick, through which air freely flows, and down whose slopes all currents of water are carried away—this arrangement preventing the entrance of ground-air into the house—an unavoidable mischief in the present style of architecture, the air of all our houses being more or less contaminated from this source. When the soil, naturally impure from the presence of carbonic-acid gas, is honeycombed, as in this city, with cesspools, and saturated with leakage from sewer-pipes, gas-pipes, and the soakings of filth-laden streets, the danger of contamination of houses from ground-air assumes considerable importance.

The liberal extent of territory occupied by our model city allows room for several broad boulevards, which constitute the chief thoroughfares, beneath each of which is a railway operated by electricity, where the heavy traffic of the city is carried on; while all the streets are so broad as to be always thoroughly ventilated, and at times flooded with sunlight. In the city of Hygeia, as described by its projector, the streets run from east to west and from north to south, as in this, our own favored town; but in the founding of *Ethica*, while keeping to the right-angled plan (though at a considerable sacrifice of artistic effect), I would choose the diagonals of these directions as tending to secure a more equal distribution of sunlight to both sides of the streets, and to all sides of the houses; since in at least one European city the death-rate has been found uniformly higher on the shady side than on the sunny side of the streets. All the open spaces in the rear of the houses are occupied as gardens, and all public buildings, including warehouses, stables, etc., are surrounded with gardens or open lawns, which add no less to the beauty than to the health of the city. The streets are paved, not exactly with gold, but with something equally impermeable to moisture, and far more agreeable to the eye, hence more conducive to comfort and health—a material comparatively noiseless and as susceptible of a clean sweep as Philadelphia at the last election. At present, concrete combines these qualities in a higher degree than any other material thus far employed, but even this leaves much to be desired, and there is room for invention in this direction. Surface-railways are not permitted in Hygeia, the underground roads being regarded as sufficient for all purposes; but in the proposed city of *Ethica*, underground roads will be used for merchandise only; passenger-railways will be elevated, thus reducing to a minimum the number of employés compelled to spend their working-hours under-

ground. These structures will be made unobjectionable by setting apart the space necessary for them, and by using electricity as the motor power. The sidewalks, paved with a gray-stone, most agreeable to the eye, slope gently toward the streets, where they meet a like gentle inclination of the streets from their centers; and by means of side-openings into the adjacent subways, which underlie the houses, the street washings and sweepings, reduced to a minimum by the abolition of street-railways, and the banishment of all traffic to the underground roads, are daily removed with the sewage; the streets are thus kept uniformly clean and dry, and the gutter being conspicuous by its absence, as the garden by its presence, the Kindergarten supersedes the *Kinder-gutter* in this scheme of civilization.

Underground rooms do not exist; hence there is no burrowing of human beings in dark and loathsome cellars, such as may be found in most large cities. The style of architecture does not admit even of basement-kitchens, where hundreds of our domestic classes spend the greater part of their lives, as effectually buried as are the laborers in a coal-mine. On the contrary, the living-part of every house begins on a level with the street, so that every room inhales the pure outside air and drinks in the liquid sunlight.

On the subject of the water-supply I hesitate to speak. At this season of the year, especially, it may be considered unwise to stir up the mental *subsidence-basin*, which must exist in the mind of every thoughtful member of this particular community; but, as this is an important feature of our model city, it calls for emphatic notice. First of all, the water is described as free from sewage or other refuse—a matter that might be supposed to go without saying, in the case of water used for drinking, were it not for the unhappy experience of more than one city which has outgrown the original source of its supply. This water, though free from all avoidable sources of contamination, is nevertheless carefully filtered before admission to the city pipes. It is also tested daily, and, if found in any degree unsatisfactory, is still further purified by the transmission through it of ozone, generated for this and other disinfecting purposes. The water, thus doubly protected, is distributed freely to every house through iron pipes, pipes of lead being strictly forbidden.

In the contemplated city of Ethica I would introduce the system of electric lighting for private as well as public uses; not only on account of its hygienic superiority, but also for its indirect moral influence, since crime lurks in darkness, and the flooding of the streets of any city at midnight with the brightness of noonday must inevitably reduce the percentage of crime, which is, to a certain extent, a matter of opportunity. The prayer, "Lead us not into temptation," is a recognition of the importance of this principle.

Radical changes in the houses appear in connection with the chimneys, the roofs, the kitchens, and their adjoining offices, for the par-

ticulars of which I refer those interested to Dr. Richardson's address, as well as for plans for the warming and ventilation of the houses, and for the safe and effectual sewering of the city; also for most important suggestions in regard to public laundries and the carrying on of certain industries (dress-making, tailoring, etc.) in the homes among the children of those engaged in such work. In connection with the last-named point, the author cites an instance as having come under his own observation, in which the half-made riding-habit, destined to figure among the fashionable frequenters of Rotten Row, was made to serve as a coverlet for the poor tailor's child, stricken with malignant scarlet fever—an incident eminently likely to occur under our present system, or want of system, of sanitation—the dangers from public laundries, as at present managed, being equally conspicuous.

It will be seen that no expense is to be spared in the building and administration of the city of Ethica. Money is abundant in the favored country of its location; the vast sums also which are expended in other cities in the support of almshouses, penitentiaries, jails, and other places of detention of incapables and criminals, are largely saved to the public treasury. As a matter of economy merely these methods would pay the best in the end, not only in the results which we have especially in view, but in actual eagles, dollars, dimes, and cents. In the State of Pennsylvania alone there are, in round numbers, five thousand insane and five thousand feeble-minded persons, who constitute a heavy burden upon the community. Those who understand the true nature of many of the causes of idiocy and insanity know that both are, to a great degree, as strictly preventable as are small-pox and diphtheria.

In that startling record of a criminal family—"the Jukes"—covering the history of several generations, it is estimated that a loss of over a million and a quarter of dollars was caused by this single family, so far as its members could be traced, without including the money expended for intoxicants, and without taking into account the entailment of pauperism and crime, or the incurable disease, idiocy and insanity growing out of these unwholesome lives—all of which bring heavy expense upon the public. But it is clearly shown in this history that the perpetuation of criminal tendencies, as of other traits, depends on the *permanence of the environment*, and that a change of external conditions may, in time, bring about a change in character. Do our laws, our courts, our jails, our almshouses, our insane hospitals, our schools and churches even, deal with the real questions presented in these statistics? Is not an exact and scientific treatment of the subject of morals, in its entire breadth and fullness, emphatically demanded; and will not the city of Ethica, when it shall arise, prove an economy in every sense of that so-often falsely used word?

But, in the pursuit of the twofold object for which Ethica is to be founded, the intelligent co-operation of all its citizens will be essential

to the full success of the experiment. To this end, special instruction in methods of personal hygiene and the hygiene of the house will be given to all, while the training of experts in public sanitation will be provided for by the public. On account of his special acquaintance with the principles of physiology and their hygienic applications, the physician will naturally become the teacher of the people in these matters, thus acting the part of a reformer in the best sense of that much-abused word, since he is the true representative of modern science as applied to the art of living in a manner alone worthy of human beings.

The moral training of children will make a part of the daily education of all their faculties, by methods which conform, in a general way, with Froebel's system. Public instruction in practical methods of moral training of children will also be provided for parents, who may not themselves have experienced the advantages of such training, and who may not fully realize that the foundations of the moral character, as of the physical health, are laid in early infancy and childhood.

To the necromancer of old was attributed the power of subverting the forces of Nature and setting her laws at defiance; but modern science has realized the pretensions of these charlatans, not by defying but by investigating the laws of Nature, and she has not only read the secrets of the stars in her magic mirror, but has penetrated to the hidden sources of human character; and while recognizing the constraining influence of external conditions in human development, she also discerns the power of human invention, human energy, and, above all, human sympathy in modifying the environment, not only by subduing the natural forces, but by directing and controlling social conditions. Under the guiding star of science, human nature reacts upon Nature, remolding her forms and redirecting her forces in accordance with its own desires and needs.

But the triumph of the scientific method is, as yet, far from complete; and not until a science of morals is as definitely recognized as a science of eclipses, or of any physical phenomenon whatever, can the era of science be said to have more than begun. When she shall have mastered the principles of morals, as she already has the principles of physics, and when the science of morals, thus formulated, shall have become an *applied* science, then real progress in morals will be assured, and will be as much more rapid than it has hitherto been, as the advance in physical science in these modern times has surpassed the slow growth of the pre-scientific era.

The doctrine that morality is to a certain degree subordinate to the physical status, though contrary to commonly received views, is evidently true. The opium-inebriate is abnormally egoistic, unsympathetic, untruthful, in short, *immoral;* the alcohol-inebriate is morally as well as physically weak and often cruel; as it has been forcibly expressed, "Alcohol reduces its subject first to a child, then to a brute."

Its effects, if long-continued, are to pauperize and permanently brutalize, just in proportion as it induces physical deterioration; and none so well as the pathologist knows the extent of the organic degeneration which accompanies and underlies the moral degradation—which is, in fact, the *corpus delicti*, the very substance and body of the offense. Hence the descent to *Avernus* by this route is not only easy, but, once fully inaugurated, the return becomes difficult if not impossible. *Hoc opus est, hoc labor est.** Such a traveler burns his bridges in crossing them, and, the physical basis of moral living being destroyed, the full restoration of the superstructure becomes a physiological and hence a moral impossibility. For the benefit of those whose thoughts are trained to run in curves—to whom a temperature-chart represents the condensed eloquence of a whole chapter of description—the statement may be made that in one of the few series of exact observations in this direction the curve of alcoholic expenditure was found to be followed by the curve of arrests for crime of all kinds, even more closely than by the curve of arrests for drunkenness; showing, to a demonstration, that the crime-stage does not always wait for the drunken-stage—that the slow and silent deterioration due to alcoholic drinks is not necessarily dependent on their *excessive* use. But from that most instructive history of the Jukes, already cited, it appears that certain physical and mental disorders often precede the appetite for stimulants, and that the real cause of their use, in a large proportion of cases, is antecedent physical exhaustion, either hereditary or acquired. Both the prevention of constitutional disease and its cure (if such a thing be possible) will then do much toward the prevention of inebriety and the crimes and lesser immoralities which grow out of it. Disease is the equivalent of weakness, and induces not only physical indifference but moral apathy. Dr. Bruce Thompson, Surgeon to the General Prison of Scotland, says: "In all my experience, I have never seen such an accumulation of morbid appearances as in the autopsies of the prisoners who die here. Almost every organ of the body is more or less diseased; and their moral nature seems equally diseased with their physical frame."

The intimate relationship between nervous diseases and crime is conspicuous. In England, the ratio of insane to sane criminals is thirty-four times as great as of the insane to the whole population, and criminal lunatics are in excess in the high proporton of seventeen to one.†

The statistics of insane hospitals in our own country show that insanity, in a large proportion of cases, is associated with unhygienic living—both overwork and want of work, as well as monotony of work, being fruitful of this kind of degeneracy. A considerable percentage of the insane women in our hospitals is drawn from country farms. The monotonous drudgery of their daily lives, and the little

* This is the need, in this is the work. † "Book of Health," Malcolm Morris.

time for reading or other means of rescue from mental torpor, are among the causes of loss of mental balance.

Dr. Elisha Harris, Corresponding Secretary of the Prison Association of New York, who has made a special study of the criminal classes, says that habitual criminals spring almost exclusively from degenerating stock. Thus, physiological unsoundness is moral decay. The inference is obvious, and the remedy for criminality from this source *stares us in the face.* Hygienic methods of living, which, with judicious medical precautions and care, tend toward the prevention of physical degeneration, will tend in an equal ratio to lessen the number of candidates for criminal careers.

The correctional discipline which is sought after (if not found) in our reformatories and prisons, is not only vastly more expensive, but far less satisfactory, than would be the application of preventive measures.

Professor Ferris, in a paper on the hygiene of schools,* says: "I can not recall ever having visited a room occupied by forty or fifty pupils that could be said to be properly ventilated; and, under the influence of impure air, study is irksome and good behavior difficult." Thus in our very schools the seeds of physical deterioration and moral degeneracy are sown in the tender bodies and unresisting minds of these *criminals of the future,* condemned beforehand—*foreordained* by their unhealthful, and hence immoral, surroundings to careers of pauperism and crime. For their future detention and safekeeping, living mausoleums are built and officered and maintained at an expense in money but grudgingly supplied for properly constructed school-houses, and at a human sacrifice which I will not attempt to estimate. The preventive method of dealing with immorality, on the other hand, anticipates the development of the potential offender by effecting ameliorations in public and individual health and by methods of education which include moral training; thus removing many of the predisposing causes of immorality—the development of sound minds in sound bodies yielding the necessary product of well-balanced lives.

Men do not, as a rule, become moral by intuition (although the moral genius, like the musical prodigy, is not unknown), but by patient organization of the moral faculties. The phenomena of vice and crime take place, not from any aberration of the laws of Nature, but in exact accordance with them, since educational neglects and unsanitary conditions, with their resulting diseases, lead to imperfect mental development or to the perversion of normal mental qualities. The development of moral activities must be recognized as dependent on the same principles as that of other activities, and the human being must be trained in morals as he is trained in athletics, in music, and in the mechanic or other arts. "By dint of forging, one becomes a blacksmith," says the French proverb; while all the talk of all the black-

* "Book of Health," Malcolm Morris.

smiths the world has ever known would not effect the desired result. "In these bewildered times," said Carlyle, "all education has run to tongue." This is emphatically true of moral education; but the "line upon line and precept upon precept" plan of moral training has ever failed, and will ever fail, of the best results. The child must be exercised in moral conduct until a real knowledge of acting rightly is acquired. The Esquimau baby cries for blubber as the American child does for sugar, and splutters at the first taste of candy as do our own pale infants on their introduction to cod-liver oil—a fair illustration of a universal principle.

Whether, then, the facts with which we have to deal be physical or whether they be moral, they have their causes: vice and virtue are products resulting from complex combinations of the more simple phenomena on which they depend. We are, in short, the true offspring, not the mere step-children, of our mother, Nature; and as our bodies are built up of and maintained by gases, fluids, and solids temporarily withdrawn from the crust of the earth and its gaseous envelope, so our characters are being continuously molded, primarily by the universal natural forces, but more immediately by the social forces incident to life in communities. Conduct is contagious. The manifestations of sentiment, of passion, of impulse, etc., excite similar manifestations in others who have the capacity for like experiences; and to the *contagia viva* of the bacteriologist must be added a moral contagion the existence of which is proved by the occurrence of epidemics of crime, especially of crimes of the gravest character. A discussion of the methods by which moral contagion is disseminated can not be entered upon at this time. Suffice it to say that, in the city of Ethica, no newspaper will be permitted to act the part of a culture-fluid for the propagation of this contagion by the publication of criminal reports which familiarize the minds of their readers with the details of crime, if they do not actually create crime epidemics. Neither will the system of inoculation—by the "sowing of wild-oats," so called, or other similar methods—receive the slightest encouragement, since this plan is more likely to establish a favorable diathesis than to secure immunity from disease. The maintenance of a high physical tone is most important, since, in the suggestive language of Rousseau, "The weaker the body, the more it commands; the stronger it is, the better it obeys"—a seeming paradox but a true indication of that state of desirable self-control which consists in the ascendency of the intellectual and moral over the instinctive and emotional traits, and which more than anything else distinguishes the highest and best exponents of humanity from its least developed types.

Having, as I believe, demonstrated the dependence of moral development upon hygienic living as its physical groundwork, and the fundamental incompatibility between physical disease and moral health,

it only remains to add that the observance of moral requirements is essential not only to physical well-being, but to the highest intellectual development and happiness; that, in fact, the pursuit of health and the cultivation of morals are alike to be regarded only as means to higher ends. It is obvious that the man of fine *physique* does not live for the observance of the laws of hygiene merely, but he observes hygienic laws as a necessary means of comfortable and wise living. So neither does the upright man live merely for the observance of moral laws, but he observes moral laws not only as the mode of living which is alone endurable to him, but as essential to the full realization of his best possibilities and powers as an intellectual and spiritual being. Personal morality has, in fact, been defined as the highest degree of *psychical health*. From this point of view it appears that as hygienic laws are an expression of the most complete adjustment between the physical life and its physical environment, so the moral law is an expression of the most complete adjustment between the psychical life and the social environment.

The most difficult of ethical problems is regarded as that of uniting the highest well-being of the individual with the greatest good of society—the reconciliation of an advantageous egoism with that degree of altruism which the welfare of society demands; but that there is ultimately no antagonism between these two objects is evident when we look deeply enough and broadly enough at the problem. The definition of morality just given brings out the fact that individual progress and the progress of society at large are inextricably associated—that we can not, if we would, separate ourselves from the great world of humanity of which we form a part.

Whoever, then, pursues a career which ministers to the welfare of society as well as to his own individual good, contributes doubly to the general progress. How conspicuously this applies to the medical life (and in a far higher sense than is generally understood) it has been my purpose to show this morning. May you pursue your chosen work with all the devotion of heart naturally inspired by scientific truth consecrated to the highest interests of humanity! In contributing to these interests, your own personal aims can not fail of satisfactory fulfillment.

The first Roman emperor whose name marks a golden era in history is said to have claimed as his greatest triumph that, having found Rome a city of sunburned brick, he should leave it a city of marble. May your ambition as far exceed that of the great Roman as the future city of ETHICA will outvalue that world-renowned city of the past! May you contribute toward the glad appearing of this long-sought paradise—this city of our dreams—whose foundations shall be laid upon recognized natural laws; whose streets shall be paved with good intentions realized; whose walls shall sparkle with the gems and fine gold of virtuous and generous conduct; and whose atmosphere

shall nourish the highest intellectual pursuits, unhindered by physical ills and unhampered by ignorant prejudice; a city, in short, in which the bodies of the inhabitants shall have become living temples of truth!

There will be no night in that city, since Truth is itself the eternal source of light, and *her torch is never inverted.*

MEXICAN ANTIQUITIES.

By RANDOLPH I. GEARE.

IN the southeast range of the National Museum at Washington is a collection of casts of Mexican statues, historical stones, and other figures of American antiquities, an examination of which alone is well worthy of a visit to the Museum. This collection was installed for exhibition by its owner, Señor Eufémio Abadiano, and was brought to Washington from New Orleans, where it had been on view at the Exposition in 1885. These casts are reproductions of precious specimens in the possession of the National Museum of Mexico, and of monuments of immense value from various parts of that republic. Our attention was first called to the "Aztec Calendar Stone," which, according to Gama, is a calendar for that part of the year between the spring and autumnal equinox, showing the movements of the sun and the times at which should be celebrated the principal feasts of the nation. In the center are four rectangles which form a figure constituting the sign of *Nahūi Ollin*, and represents the four movements of the sun. The figures in the circle outside of these rectangles represent the twenty days into which the month was divided. The divisions of the day are shown by eight large angles. The stone served as a sun-dial, by means of which the times for ceremonies and sacrifices were ascertained daily. The original monument is believed to weigh twenty-one tons. Close by is the cast of the statue *Teoyoamiqui*, or Goddess of Death, about eight

TEOYOAMIQUI, OR GODDESS OF DEATH.

feet and a half in height. The original was found buried in the city of Mexico ninety-six years ago. Humboldt believes that this and other idols were placed under-ground by Cortes and his men in order to escape the observation of the Aztecs, to whom these idols would doubtless prove a serious obstacle to their embracing Christianity; but it seems more reasonable to suppose that these idols were buried by the Aztecs themselves, in order to prevent their capture by the soldiers. The goddess *Teoyoamiqui* was charged with the gathering in of the souls of persons killed in battle, it being supposed that their souls went to the mansion of the sun in heaven, where they were eventually transformed into humming-birds.* Near this is a cast of the statue of the goddess *Mictlanteuhtli*, who presided over *Mictlanteuhtli*, by which name the Mexicans denoted the place to which the souls of those who died natural deaths were transmitted.

Perhaps the most interesting cast in this collection is that of the Sacrificial Stone, which was found ninety-five years ago in the city of Mexico. The complex figures and hieroglyphics on this stone utterly astound the visitor to the Museum, and are only to be descried, to say nothing of being understood, after the most careful examination. This stone is about two feet eleven inches high and more than twenty-seven feet in circumference. On its face is sculptured the image of the sun, and around the stone are fifteen groups of two persons each, one of each couple being represented as victorious over the other. The number of victims indicates the number of conquered tribes. In two couples the victim is a woman, which probably denotes that those two tribes were governed by women. A groove running to the margin from the center marks the course for the flow of the victim's blood. The conqueror is Tizoc, sixth king of Mexico, who reigned from 1481 to 1486, and the monument is commemorative of his victories. A cast of the famous statue of Chac-Mool (tiger), about two feet six inches high, is in the collection. The statue is believed to be twelve thousand years old, and was, it is said, erected to the memory of Chac-Mool by his wife. In the valley of Mexico and in Tlascala statues of similar form have been found, and it is therefore assumed by some that the same divinity was worshiped both in Mexico and Yucatan. The statue was discovered by Dr. A. Le Plongeon in the ruins of Chichen-Itza, Yucatan, and removed by the Mexican Government to the National Museum of Mexico. Of exceeding interest is the reproduction of the Commemorative Stone in remembrance of laying the foundation of the great temple of the Aztecs, the building of which was commenced by *Tizoc*, who was desirous of erecting a sacred edifice which should be the wonder of all the nations on earth. It was not finished by him, its completion being reserved for *Ahuitzotl*, his successor, in the year 1487. This temple has now given place to a magnificent

* Charero, in his "Anales del Museo Nacional de Méjico," vol. ii, p. 293, holds that it represents the earth-god, *Coatlicue*.

cathedral. A cast of a cylinder known as "The Mexican Cycle" is very interesting. Among the Aztecs every fifth day was a day of rest, called *Tianquiztli*, and five of these periods constituted a month of twenty days, eighteen of which made up a year of three hundred and sixty days, to which were added five more to make up the proper length of the year. The cycle or century was composed of fifty-two

Sacrificial Stone, or Cuauhxicalli of Tizoc.

years. This cylinder is composed of a bundle of reeds tied with cords, representing a cycle, or *xuihmolpilli* in the Mexican idiom, the signification of the word being a "union of years." The Aztecs believed that at the close of the cycle the world would come to an end, and the last night of the cycle was a time of great anxiety for them. They destroyed their goods, threw away their valuables, and offered human sacrifices. As soon as the moment of suspense was passed, and it was seen that the world had not been destroyed, but would last another

century, sadness and penitence gave way to the greatest hilarity, the beginning of the feast being signalized by the priests, who, with the aid of two dry sticks, ignited a fire which was carried far and wide in token of the continuance of the world's existence.

Placed near by is a cast of an immense head, which is supposed to have occupied a position in the great Aztec temple. Some archæologists believe that it represents the lost Atlantis, with her head-dress of water dotted with shells. In the Mexican town of Tenango was found a stone about five feet ten inches high, upon which are sculptured the four fatal epochs in Nature which the Aztecs assert had taken place. These epochs are *Atonatiuh*, or water-sun (corresponding to our deluge); *Ehecatonatiuh*, or wind-sun; *Tletonatiuh*, or fire-sun; and *Tlaltonatiuh*, or earth-sun. A cast of this stone is among the series. We also notice a cast of the "Cross of Palenque." The use of this symbol by the Mexicans of remote date is by some advanced as an argument to prove that, at that time, Christianity was established, or at least taught, in their country. Others, however, regard the symbol merely as an astronomical sign, indicative of the four seasons, four winds, etc. On this cross is represented a priest offering up a child to the sacred bird, which is perched on the top. At the bottom of the cross is a large face with open mouth and an ornament hanging from its nose. The "Palenque Divinity" is represented by the figure of a god on whose head is a diadem of plumes. On the forehead is typified "Eve's Serpent," in the form of a star, whose presence in the heavens is significant of harvest-time. This is the god that creates and is opposed to the destructive genius. The serpent referred to was *Sérapis* among the Egyptians, *Wischnou* with the Indians, *Vitzlipultzi* in Mexico, *Fohi* in China, *Esculapie* with the Greeks, and *Thor* among the Scandinavians. There is also a cast of a bas-relief supposed to have come from Palenque. On it is depicted a man being punished in some way, his hands tied behind him, and

COLOSSAL HEAD OF TENANGO.

extreme pain being evident both in his face and from his attitude. A cast of what is believed to be a statue of *Chalchiuhtlicue*, Goddess of Water, was also shown us. The statue came from a mountain near Tlalmenalco. This divinity was sister to the gods of water, *Tlaloques*. A yoke from Orizaba is in the collection. This is made of stone and is of a green color. At the top of the yoke is a head, like that of a snake, and the entire yoke is polished. These were used on the occasion of human sacrifices, and were placed over the heads of the victims whose hearts were to be taken out. Next in order is the cast of a statue of a woman who, by her costume, appears to have belonged to the Aztec nobility. Around her waist is a rattlesnake, and this fact leads to the supposition that the statue is that of the "snake-woman"—the goddess *Cihuacoatl*, from whom the Aztecs believe the entire human race has descended. There are also in the collection casts of two feathered serpents and other mythological animals; of a

FEATHERED SERPENT.

humpback, who is supposed to have been a son of King Tizoc, to whom reference has been made; of the water-goddess, etc. Conspicuous, too, are two funeral urns, beautifully carved inside, and with skulls upon the convex surface. A great vase or tub is in this series. From various water-animals sculptured on the base it is supposed to be commemorative of the deluge, but little is known of its meaning. A large grasshopper (*Chapolin*) stands near the "tub," and is supposed to be commemorative of the end of the wanderings of the Aztec tribe which terminated at Chapultepec (hill of the grasshopper).

Neither time nor space will allow a detailed description of some of the smaller casts in the collection. It is, however, safe to say that every piece has connected with it an interesting history.

PRAIRIE-FLOWERS OF EARLY SPRING.

By BYRON D. HALSTED, Sc. D.,
PROFESSOR OF BOTANY, IOWA AGRICULTURAL COLLEGE.

BOTANY has so changed, broadened, and deepened, within the past twenty years, that it may seem like retrogression to talk of flowers. The average botanist of to-day has gone so far beyond mere blossoms, as such, in his study of minute anatomy or in his experiments upon vegetable physiology, that he sometimes almost forgets there are such things as sepals and petals. He must confine himself to a single cell, or at most a group of cells; a tissue, or possibly a tissue system, or else his associates will speak of him as being so broad that he must be shallow. The division of labor, in fact, has gone so far that one person studies pollen for a lifetime, while another counts that day lost in which he does not gain some new fact upon the endless subject of chlorophyl. There are hundreds of noted botanists who pay no attention to flowering plants except as they are the hosts of, and subject to destructive inroads from, the almost countless species of cryptogamic plants belonging to the rusts, smuts, blights, mildews, and molds.

It therefore requires much courage in this age of advanced botanical thought to attempt to write upon a theme that is so broad as the one selected. "Spring flowers" bears the marks of wear, especially in the hands of those who can do almost anything better than make rhymes. The practical eye of the penetrating student of plant-life has gone beyond the beauty in flowers, and finds a golden thread of adaptation which the average "spring poet" has never dreamed of, even in his highest flights after the soul of things. However, for the genuine poets be it said that it was reserved for the immortal Goethe to first comprehend the true morphology of seemingly so simple a structure as a flower.

The season of flowers opened unusually early this year—how much more so than the average can only be told after observations have been taken over a series of years. Ten years from now it is hoped that the record will be so complete that, with watch in hand, the hour may be given when a certain flower may be expected. There is doubtless a floral clock for the year as there is one for the twenty-four hours of a single day. Perhaps there has been a great Phyto-convention held somewhere, and a majority, if not all, of the choice bloomers were in attendance. Each was assigned its place in the calendar, and if the petals do not unfold and fade away with the regularity of the unerring time-piece, it is no fault of the plant. Upon the surrounding circumstances, and not upon the plant, must rest any blame for irregularity. To any one who has made a careful inspection of the

thoroughness with which the pussy-willow prepares for the coming spring, even before the first chill of autumn thrills the summer air, it will be unnecessary to dwell upon this fact. Even in these October days, when the leaves are chasing each other down the roadway, driven by the cruel wind, there are bright promises of another spring-time left behind upon the shrubs and trees. The foliage may fall, but its work remains. Their long summer days of toil are not for naught. Within the closely knit covering of the bud sit the germ of a future branch with its leaves defined and its flowers planned. Those who see only evidences of death and decay in the leaf-stripped tree are surface-sighted. A plant is never more itself than when it is fully prepared for a period of repose. It is now most independent and most highly charged with what the physicist would call the energy of position. The plants, therefore, that bloom early in the spring are not idlers through the balance of the year; they ripen their seed, or, in other words, rear up a fine family of children. Each offspring, provided with an outfit for the early struggles of life in the shape of starch, and oil, and protoplasm, is invited to shift for itself. More than this, the mother-plant, if it is the plan that she shall live on, spreads new leaves to the sunshine, and the work of food-making goes on during every day until a store of nourishment is packed away for use in the early growth of the plant the following spring. As a rule, spring flowers are made out of last year's material, and, in this sense, are not as fresh and new as those that come later in the season.

Over fifty pairs of anxious eyes were watching last spring for the first flowers of the year, and it is safe to say that not many days elapsed between the appearance of the first blooms of a species and the time they were discovered. It was none other than the hepatica, or liver-leaf, that first opened its delicate blossoms to the chill air. This was on April 6th, and many days before the snow-banks had silently stolen away. The fact that this little forerunner of warmer and better days has been recently uprooted by botanists and transplanted in another genus seems only to quicken its pulse and make it breathe the air of April more freely. *Hepatica acutiloba* (DC.), of my earlier botanical days, has changed to *Anemone acutiloba* (Lawson). It by any other binomial botanical title would bloom as early and smell as sweet. Its twin sister has undergone a more violent treatment, and, instead of *Hepatica tribola* (Chaix), it is settled among the wind-flowers as *Anemone hepatica*, where the immortal Linnæus had placed it a century ago. The fineness and even brittleness of the thread by which a species is hung is well illustrated by these two hepaticas. Without considering how minute were the characteristics upon which the genus *Hepatica* was founded by Dillenius, let us see in what the two American species differ. Dr. Gray, in his "School and Field-Book," says: "*Hepatica triloba* (round-lobed hepatica), leaves, with three broad and rounded lobes, appearing later than the flowers and lasting over win-

ter; stalks hairy; flowers blue, purple, or almost white; woods, common East. *H. acutiloba* (sharp-lobed hepatica), wild from Vermont, West, has pointed lobes to the leaves, sometimes five of them, and paler flowers."

We are not favored with the round-lobed hepatica in this vicinity, and can not say from observation how bright its flowers might be in the pure, clear atmosphere of this prairie-region; but it is true that the sharp-lobed species does not *pale* in comparison with the Eastern flowers of the *A. hepatica*, unless my memory has faded in the mean time. The blue we get is deeper than can be caught from the sky on our clearest April day. There remains little else upon which to hang the species except the shape of the lobes of the leaves, and this is exceedingly variable. Last spring a patch of a hundred blooms or more grew close by the retreating edge of a snow-bank, only a few feet from my window, and the little clusters of blossoms varied so much among each other that an unobserving person would look the second time to note the shades of color. The foliage in like manner varied, and in some instances it seemed that there was evidence enough in that one bed to overthrow the strongest belief in there being two species of American hepaticas. I say we do not have more than one species here, and that is largely due to the fact that it is easier for us to put them all under *A. acutiloba* than to try and distinguish the two. To say that the acute-lobed leaves are sometimes five-lobed, is no distinction. In the college herbarium is a specimen of the roundest of the round-lobed from Michigan, with this same characteristic. The greater number of sepals (seven to twelve) in the *A. acutiloba*, there being six to nine in the other, has little weight, especially if we examine the specimens of *A. hepatica* from Europe. In turning to "The Manual," it is found that Dr. Gray, of course, comprehends the situation, and adds the following "saving clause" at the close of the description of *H. acutiloba:* "Perhaps runs into the other."

One further observation upon the hepatica, and then we will hasten on to other and quickly following April flowers. One plant of the *A. acutiloba* was found, the calyx of which was unusually small and dark blue, while the involucre was larger than ordinary. A closer examination revealed that these flowers were pistillate, and only vestiges of stamens could be found, and these in only two of the many flowers. The pistils, thirty-five to fifty in each flower, were about double the average number in ordinary blossoms. The plant seemed to be quite generally "off the track." The involucre of one flower had a fourth leaf (the ordinary number being three), which resembled a sepal in form and bright color. One of the three green leaves of the same involucre, instead of being of the normal entire form, was trilobed at the tip, giving it a strong resemblance to a leaflet of the meadow-rues (*Thalictrum*), an adjoining genus. Upon looking up this interesting unisexual tendency in the hepatica, it was found that Dr. S. Calloni

had recently made a similar observation in Europe on *Anemone hepatica*, as indicated in the "Journal of the Royal Microscopical Society" for April of the present year.

The next in order of time of our early-blooming plants comes the wild hazel (*Corylus Americana*, Walt.). This shrub would be passed by by the seeker of showy blossoms. Like most of the species of its order (*Cupuliferæ*), including the oak, chestnut, beech, and hornbeams, the staminate or male flowers are in drooping, cylindrical clusters, without any showy calyx or corolla. The pistillate or female flowers are elsewhere upon the same shrub, and are likewise inconspicuous. We have, therefore, in our first two flowering species, many widely different characteristics. The hepatica is a small herb that clings close to the earth, and may flourish under the protection that the hazel-bush yields it. The liver-leaf has showy flowers, which it holds up on long stalks in a conspicuous manner, and bears in each blossom both the essential organs (stamens and pistils) for the production of seed. The hazel has its sexes separated on the same shrub, and attempts no display of attractive color or forms. These two species, that bloom on almost the same early April day, have so little in common that they can not be rivals in any sense. They are moving along on independent lines, which for each, under its particular circumstances, are lines of least resistance. It may be that in this thought we find a solution of the problem of their very early blooming.

On April 11th two widely different plants were found in flower, namely, the first of the sedges (*Carex Pennsylvanica*, L.), and the blood-root (*Sanguinaria Canadensis*, L.). The little early sedge may claim some kinship with the hazel in this, that the flowers are of two kinds, and the staminate or pollen-bearing are more conspicuous than the inobtrusive pistillate or seed-bearing blossoms. Both the hazel and sedge depend upon the capricious winds for the transport of their pollen from the male to the female flowers. Darwin claimed that "Nature abhors continual close fertilization"; that is, the fertilization of the ovules of a flower by the pollen of the same blossom. In the hazel and the sedge we find the strongest sort of proof of such a doctrine. Close fertilization is impossible, from the simple fact that each flower is unisexual. The blood-root presents us with another side of the great and interesting subject of adaptations for cross-fertilization which was developed by Conrad Sprengel nearly a century ago, and given its present form by Darwin in 1862. What lover of flowers does not know the blood-root in its home among the decaying leaves along hedge-rows and out in the rich, open woods? Who does not recall the strangely and neatly lobed palmate leaf, up through the coil of which the plump bud pushes its way, and in a day has blossomed and gone? It may be some young botanists have been puzzled over the "sepals 2" of the manuals, forgetting that this wide-awake plant, having no further need for the firm, protective covering to the flower-buds,

drops its two sepals as they open, leaving the delicate, pure, white petals and the April insects to succeed as best they can in the work of cross-fertilization. Just what kinds of bees, or bugs, or beetles stand ready to rob each opening flower of its sticky pollen, I am not prepared to say. It is true that the blood-root has few competitors, at this time of year, for the employment of the insect tribes. Its petals are large, and doubtless catch the watchful eyes of the hungry insects at long range. The plant and the insect work together, each selfishly, yet each successfully. The mutual adaptation existing between some flowers, as those of many orchids and their attendant insects, is so complete that neither the plants nor the insects could well exist without one another. Some plants are absolutely dependent upon certain insects for the transfer of their pollen, while these same insects could not subsist without the flowers from which to extract their daily food. In our little blood-root, we do not believe such a thorough dependence exists. If insects do not bring more potent pollen from some other flower, that of its own, falling upon the stigma close by, will suffice.

On April 13th two species were found in flower, and between them there are seemingly wider differences of structure than were pointed out in the last two. The white elm (*Ulmus Americana*, L.) is a large tree, famous for its grace and beauty in the hands of the landscape-gardener. The *Stellaria media* (Smith) is the common chickweed, so abundant around dwellings in every part of the world. The stately elm is an American species, as its botanical name indicates, while the chickweed is one of a large class of plants which have come to us unbidden, and frequently unwelcomed, from beyond the sea. Its greatest economic value seems to be as a salad-plant for canary and other imprisoned birds. This little, insignificant herb delights in cold, shady soil, and frequently opens its blossoms beneath, or when surrounded by, drifts of snow. There seems to be no good foundation for this haste, as the plant continues in bloom during nearly its whole lifetime of a year or more. It also seems as if it would be just as well to delay flowering until insects are more numerous, at which times the blossoms secrete so much honey that the drops may be seen without a hand-lens. Among other insects, the prolific aphides (plant-lice) and the ubiquitous house-fly (*Musca domestica*, L.) are attendant upon the unobtrusive chickweed-flowers. The blossoms of the elm are also small, but depend upon the winds for transfer of their pollen. The leaves do not unfold until the flowers are past, and in this circumstance we may see an instance of the working of the law of adaptation. The foliage might interfere with the easy movement of the dry, dusty pollen from one tree or branch to another. Students of plant-life are always pleased to observe that adaptations for cross-fertilization are worked out along very many lines. The elm offers an instance in which there is a seeming confusion in the floral type. Botanists say the elms are polygamous, which only means that some flowers are per-

fect or hermaphroditic, having both stamens and pistil, while others are unisexual, being either staminate or pistillate. This appears to indicate that the elm is passing through a transition state, either toward a final separation of the sexes, as in the hazel, or is approaching those plants which have their flowers all perfect, as the magnolias or tulip-trees.

The *Ranunculus repens* (L.) opened its bright-yellow petals on April 14th, and was the only new flower for that date. This creeping buttercup is one of a large genus which takes its name from the Latin word for a little frog, applied to these plants by Pliny, because many species are aquatic and abound with the frogs. The English farmers rank this early spring plant among their weeds, and like many other plant-pests it has a remarkable provision for spreading and occupying the land. Shortly after the flowers have faded the plants send out runners which quickly take root at their joints as in the strawberry, and before midsummer has passed the mother-plant may have a brood of young extending far beyond the protection of her "wings" or leaves.

April 15th has four species recorded against it on the note-book, namely: *Isopyrum biternatum* (T. and G.), *Dicentra cucullaria* (DC.), *Capsella Bursa-pastoris* (Moench), and *Erythronium albidum* (Nutt). What a variety is here presented in so small a number! There are as many orders represented as species. One is an endogen of the lily family, and should be called spring-lily, instead of white dog's-tooth violet. There is very little to suggest a violet in shape or color, and, as for the "dog's-tooth" part, the quicker it is extracted the better! The other three species are disposed among the exogens; the isopyrum, or enemion, falling in close by the side of the crowfoots and the marsh-mangolds, but a thousand times more delicate in habit than the latter. It is the ordinary wind-flower exalted in its foliage to the attractiveness of a maiden-hair fern. The student, during his first spring among the early flowers, is quite liable to confuse this isopyrum with the rue-anemone (*Thalictrum anemonoides*, Michx.). At this he should not grieve because older heads have been troubled with this little thalictrum—which now is no more a thalictrum. Of it De Candolle wrote, "Habit and frondescence of isopyrum with the inflorescence of anemone and the fruit of thalictrum." Spach has placed the little puzzler in a new genus and calls it a little anemone that is much like a thalictrum, viz., *Anemonella thalictroides*. This is only one of many instances where further study of a species has led to a new setting in the system; in fact, a large part of the work of the systematic botanist in the future will be the erasing of old, confusing, ill-defined lines, and the drawing of clearer and stronger ones. But, wherever the rue-anemone may go in the classification, its likeness to the isopyrum will remain, and, coming as these two plants do at the same time in April, they will always furnish a test for the discriminating powers

of the student. To these two species add the wind-flower (*Anemone nemorosa*, L.), all of which appear at about the same time and in similar situations, and the student has three forms over which he may work for some hours before the representations of the three genera are satisfactorily determined. It is, however, just such work that opens the eyes of the young naturalist and makes him mindful of little things. The shepherd's-purse (*Capsella Bursa-pastoris*, Moench) is an intruder from Europe that has found its way into our cultivated ground, and become most ugly because so much in the way of other and better plants. This weed seems to be running a race to the seed-goal with some other of our plant-pests. During the present season strings were tied upon certain flower-stalks when their flowers were in bloom, and a record was kept of the time required for the maturing of the seed. The number of days varied from fourteen to seventeen. This is in striking contrast with the two long years of maturation required for the acorns of many species of oaks. The ubiquitous dandelion can, however, win the pennant for quick-seeding from the shepherd's-purse. It can reach the home-line when capsulla is only half-way round the track. But while a dandelion-plant, on an average, produces 1,720 seeds, the shepherd's-purse ripens 17,600, or more than ten to one! The same student has determined this year that these figures are low indeed when compared with those for the offspring of the purslane speedwell (*Veronica peregrina*, L.). This small plant began flowering on May 3d, and before six weeks were past it had produced 186,292 seeds. What some plants may lack in size and durability they make more than whole by wonderful powers of reproduction. The *Dicentra cucullaria* (DC.) is the interesting "Dutchman's breeches," with the heart-shaped corolla, much like its cultivated favorite sister, the *Dicentra spectabilis* (DC.), better known as "bleeding-heart," with its long, gracefully bending stems, each bearing a dozen or more of rosy "hearts." Our early wild dicentra exceeds its cultured relative in delicacy and beauty of foliage and its strange-shaped flowers, which are, although smaller and less highly colored, not less interesting structurally. The visiting insect, intent upon securing the honey secreted at the base of the petals, must brush aside a close-fitting cap or hood before the pollen and the stigma may be touched. The two canals leading to the nectar are so constructed that the insect, usually a bee, in thrusting his proboscis into either, brings his body against the hood and, pushing it aside, dusts fresh pollen from some other flower upon the stigma. Before he leaves, new pollen is unintentionally secured by the insect for the fertilization of the next flower visited. The hood of the pendent blossom falls back to its accustomed place as soon as the bee retires, and again incloses the pistil and the six stamens situated close around it. When we remember that the stamens of a particular flower may mature before its stigma, it is easy to understand that the pollen of that flower, although placed close by the side of the stigma,

is designed for some other flower, and the presence of nectar and proboscis-canals, as well as a fine landing-place for the bee, at the base of the hanging corolla, are all to secure cross-fertilization. This little species has worked out the problem in a most interesting way, and doubtless the insects have had much to do with determining these final results.

The box-elder and the silver-maple began blooming on April 16th. There is no evident relation between size of plant and extent of floral structure. Some Alpine gentians have flowers an inch long, while the balance of the plant is shorter and probably has less weight than the single blossom it bears. The most wonderful flower of all is that of *Rafflesia Arnoldi*, which sometimes measures nine feet in circumference and weighs fifteen pounds. These monstrous blossoms are almost without stem, being sessile (sitting) upon the branch of the vine from which as a parasite the flower derives its nourishment. In striking contrast with this obese robber the stately and independent silver-maple has inconspicuous flowers that might be readily overlooked if they did not appear before the foliage. The genus *Acer*, to which the silver or soft maple belongs, is very variable in this last point. Some species, like the one in hand (*Acer dasycarpum*, Eh.), flower before unfolding the leaves; others, like the highly prized sugar-maple, have the flowers and leaves appear at the same time; while others are laggards, and bring forth their blossoms after the leaves are fully formed and busy with their work. The same differences hold as to the time of ripening the seeds. The silver-maple has its seeds ready for the last breezes of May, and upon the large wing each little plantlet takes an airing that the thoughtful student watches with much delight. If the breeze is strong, the seed passes along with the unsteady and rapid progress of a butterfly, usually with a downward course from the tree-top, where it was borne, but sometimes it rises and hastens on, perhaps to fall on rich soil a hundred rods from the parent tree. Each of these winged fruits bears a single seed within, and as the fruit falls upon the ground the heavy end strikes first, thus bringing the root of the little plantlet in the best position for rapid development. When the fruits fall upon sod-ground, the condition that often obtains in Nature, the passing breezes play upon the uplifted wing and tend to work the heavy seed end of the fruit into the turf. Under favorable conditions the soft-maple seeds germinate at once, and, before the season closes, seedlings a foot or two in height may be produced. The late-flowering maples do not make any such progress, and seem satisfied if they simply secure a good crop of seeds. In order to test the importance of the soft-maple seeds obtaining a suitable place for germination as soon as they are mature, a quantity were gathered and stored in a dry place, where other seeds are kept. A year after they were sown in rich, moist soil, alongside of a row freshly gathered from under the same trees. None of the year-old seeds grew, while the fresh ones soon sent up their

stems and leaves. The silver-maple plantlet is pulpy and already of a deep green when it falls from the tree, and probably is killed as soon as it becomes thoroughly dried. The seed runs many risks for the sake of being a sizable seedling the same season.

The box-elder (*Negundo aceroides*, Moench) belongs to a most closely related genus to the maples, and by some botanists it is placed with them in the genus *Acer*. The most striking difference is seen in the leaves, those of the box-elder being compound like the ash, hence one of the common names, "ash-leaved maple," while the leaves of the familiar maples are simple. In the box-elder the sexes are separated much more clearly than in the maples. One tree bears only staminate flowers while another has only pistillate blossoms, and therefore bears the fruit. To have good seeds it is necessary that at least two box-elder trees be in the same vicinity, and one of these must be male and the other female. This tree is the type of hardiness in the severe climate of the Northwest, but in this connection there are some points not easy of explanation. The box-elder of one section of the country may be identical in structure with specimens in a different climate, but widely different in hardiness. This brings to view again the law of adaptation as applied to the inherent ability to withstand the untoward circumstances that have surrounded the ancestry for long periods in the past. The same is true of many other species growing over wide areas of country. They may possibly retain the same botanical characteristics, but beyond all that the eye, with the aid of the best microscopes, can see, there is that which enables one plant to flourish when another will fail.

The 17th of April brought blossoms of *Caltha palustris* (L.), and *Carex stricta* (Lam.). The first is the marsh-marigold, or perhaps more familiarly known as the "cowslip." The genuine cowslip of the poets is a different plant, it being a primrose. The caltha is a pot-herb of no great merit, and does not possess that type of beauty which inspires the muse. The carex is the second sedge of the season. It doubtless has its place to fill in the scheme of creation.

April 18th introduced us to three species, the *Populus monilifera* (Ait.), or cottonwood; *Antenaria plantaginifolia* (Hook), the plantain-leaved everlasting; and *Viola palmata*, var. *cucullata* (Gray), the common blue violet. Spring has now fairly opened, for the violets have come. This day throws together in the list three very different plants. The poplar is one of the most wide-spread and hardiest of trees. It is the only kind of arboreal vegetation in many places along water-courses of the Northwest, in regions subject to severe climatic conditions. It can bear the heat and drought of summer and the extreme cold of winter when other forms succumb. It may be worthy of note that this hardy tree produces timber that is among the lightest on the list of woods in the United States. Its specific gravity is only .3886, or a little more than one third as heavy as water. We

have sixteen species of trees yielding wood heavier than water. Nearly all of these are in the Southern States, and several are confined to the extreme south of Florida, which is a tropical or sub-tropical region. The Southern pine (*Pinus palustris*, L.), from which we get an excellent lumber, besides pitch, tar, turpentine, etc., is nearly twice as heavy as the Northern or white pine (*Pinus strobus*, L.). The very hardy box-elder yields only a light wood. It would seem that firmness of texture and great specific gravity of wood are not characteristics that accompany ability to induce wide ranges of conditions and sudden changes in temperature.

The little everlasting, with leaves like the plantain, although covered with a soft, silky wool, is the earliest representative of the largest of all the natural orders of flowering plants, the *Compositæ* or sunflower family. It does not announce its coming into bloom by any display of showy colors, and the young naturalist could be forgiven for either not seeing it, or not desiring to struggle with it, through the bewildering maze of the key to the genera of this difficult order.

The *Viola cucullata* of Aiton has gone, and in its place we must write *V. palmata*, var. *cucullata*. Dr. Gray, in his recent revision of the North American violets, of which he finds thirty-three species, has restored *Viola palmata* of Linnæus. This is a very variable species. There seems to be no part of leaf or flower that is not subject to a wide range of variation, unless we except the three-valved pod with its single cavity. Many species of violets are remarkable for a second kind of flowers, which are inconspicuous, closed, and self-fertile. They may be found in all stages of development beneath the soil and throughout the growing season. Last autumn the writer gathered a quantity of the seed from the underground pods and mixed them with seeds from pods produced by the ordinary flowers, and no one of the many persons to whom the mixture was submitted could detect any difference. Yesterday (October 14th) a class of one hundred students in elementary botany analyzed the *Viola palmata*, L. Abundant material for this exercise was obtained on a piece of land near a railroad that had been burned over during the prolonged drought which lasted for more than two months in midsummer. The plants having passed through so severe a season, which was followed by abundant warm rains, perhaps have been deceived, and are arrayed in the garb they had prepared for spring. The form with entire leaves—the old *V. cucullata*—tinge the bank of the railroad-track with their unusually high-colored flowers, while the *palmata* is abundant on the higher land. The *V. delphinifolia* (Nutt.) is our most common violet of spring, but it has not been found in bloom this autumn, nor has any other than the ones mentioned been reported, although we have eight or more species and some varieties in the State.

The 20th of the month of showers, of smiles and tears, as the poet would say or has said, brought out the *Amelanchier Canadensis*

(T. and G.), and five other species. The amelanchier is often called "shad-bush" in the Eastern States, when the famous river-fish of spring have their period for ascending the streams, which time corresponds somewhat with the blossoming of the amelanchier. "June-berry" and "service-berry" are other names for this small tree, which, when in full bloom, is very attractive. The wild strawberry (*Fragaria Virginiana*, Ehrh.), a member of the same family (*Rosaceæ*) with the "June-berry," is recorded for the same day. The best of all strawberries, even in this age of a thousand cultivated varieties, were those gathered in youth upon the grassy hill-side. The flavor of the wild strawberry is nearly lost in many of the larger and more showy fruits of her highly pampered offspring. The toothwort, or dentaria (*Dentaria laciniata*, Muhl), and *Draba Caroliniana* (Walt.), or "whitlow-grass," come almost side by side in the manual as members of the *Cruciferæ* or mustard family. In the first we have an old friend of childhood days. Many an eager youth has burrowed his fingers deeply into the rich leaf-mold and earth, in search of the little potato-like root-stocks filled with a peppery and toothsome substance. The mustard-like flavor gets too strong as the root-stocks grow old, so that the luxury of gathering them in early spring is appreciated. Unlike its nearly related toothwort, the draba is a lover of sandy, waste places, where it, in its smallness and feeble growth, can have its own way. It does not enter into the sharp competition with other plants for the possession of the rich soil. Its strength and durability reside in its being content with poor fare.

The last but far from the least of the five flowering plants for April 20th was nothing less than the smooth lungwort (*Mertensia Virginica*, DC.). The bell-shaped flowers are of the choicest blue, a color that is both rare and beautiful in plants. It is no wonder that it has been transported from the moist banks of streams to adorn the flower-border in early spring, under the name of "blue-bells" or "Virginia cowslip," or, better still, "Mertensia," the generic name, taken from a German botanist, Mertens. The West has several of the mertensias, the most striking of which, to travelers in the Rocky Mountains and Sierra Nevadas, is the *Mertensia Siberica* (Don.). It covers the borders of mountain-streams with a rank herbage three to five feet in height, bearing a profusion of bright, light-blue flowers. This giant of the dashing mountain-streams has its dwarf form (var. *Drummondii*, Gray) upon the far-away Arctic sea-shore.

April 21st finds the prickly-ash (*Zanthoxylum Americanum*, Mill), the small flowered buttercup (*Ranunculus abortivus*, L.), and the round-leaved gooseberry (*Ribes rotundifolia*, Michx.), in bloom. The prickly-ash, sometimes called "toothache-tree," is perhaps the nearest of kin of the orange, lemon, lime, and shaddock that grows in this flora. The aromatic bark and pungent leaves are a poor reflection of the very agreeable aroma that accompanies the fruit of the tropical

relatives. This disagreeable shrub, to make itself doubly sure of escaping the ravages of foraging animals, has armed itself with multitudes of keen prickles upon all its parts. It has won in the race, for in many places on the low land along the streams it occupies the ground to the exclusion of all else of a woody nature. The small-flowered buttercup is an instance of where, in a large genus having mostly showy flowers, the petals of a species may be much reduced. The wild gooseberry is a plant with possibilities that still remain undeveloped. It may have vast resources that only the practical horticulturist can develop in his own time and way. The gooseberry is not the only wild fruit plant that deserves the quickening hand of skill to bring it, in an improved and acceptable form, before the world. Our wild apples, plums, cherries, blackberries, thorn-apples, papaws, huckleberries, cranberries, and an extended list of native fruits, are all hopeful subjects for the fruit-grower. Let any who would begin the work of subjugation look at the results already obtained from the culture of the American grapes.

The 22d of the month has *Astragalus caryocarpus* (Ker.) and *Celtis occidentalis* (L.) scored against it. The former is a vetch, with a pod so hard and plump that it has taken the common name of "ground-plum." The latter, the hackberry, is a choice tree closely related to the elms, but bearing berry-like fruits instead of those with wings.

From this time forward the list for each day lengthens. For the 23d, the dandelion (*Taraxacum officinale*, Weber); the two wood-sorrels (*Oxalis violacea*, L., and *O. corniculata*, var. *stricta*, Sav.); false Solomon's-seal (*Smilacina stellata*, Desp.); wild ginger (*Asarum Canadensis*, L.); slippery-elm (*Ulmus fulva*, Michaux); and the wild sweet-william (*Phlox divaricata*, L.), make up a full list that ought to satisfy any ambitious collector. If we except the slippery-elm and the dandelion—the latter, because it grows as a weed in our lawn and not from any lack of inherent beauty—we have five species of spring flowers, strictly so called, and objects of the flower-hunter's search. The tyro will be quite sure to find the "prairie phlox" with its high and showy flower-cluster, and likewise he should return with the first of the smilacinas and the sorrels, but no blame will rest upon his head if he oversteps the inconspicuous although large flowers of the wild ginger that shyly keep close upon the ground beneath the plant's large reniform leaves. The next day added the following to the list of plants in flower: Gill or ground-ivy (*Nepeta glichoma*, Benth.); the great bellwort (*Uvularia grandiflora*, Smith); the little *Anemonella thalictroides* (Spach.), before mentioned with isopyrum; and *Ostrya Virginica* (Willd.), the hop-hornbeam. The bellwort has the most showy flower of the day, and the hornbeam the least conspicuous. April 25th continues the list as follows: The star-grass (*Hypoxis erecta*, L.), the old hand-leaf violet (*V. cuculata*, var. *palmata*, Gray),

its close of kin the larkspur-violet (*V. delphinifolia*, Nutt.), and the Indian turnip (*Arasæma triphyllum*, Low.), sometimes better known as "Jack-in-the-pulpit." The writer will never forget his first introduction to the tuberous root-stock, or "turnip," of the last-named plant. The mean face of the full-grown man who prepared a slice of the "turnip" for me (then only an inexperienced child) has never faded from my memory. My directions were to chew it and swallow all quickly. Only those who have tasted of the corm know how intensely acrid its substance can be.

For the balance of the month, and in the order here given, the following plants came into bloom: The bur-oak (*Quercus macrocarpa*, Michx.); wild plum (*Prunus Americana*, Marsh); white-oak (*Quercus alba*, L.); butternut (*Juglans cinerea*, L.); spike-rush (*Eliocharis obtusa*, Sch.); columbine (*Aquilegia Canadensis*, L.); hard maple (*Acer saccharinum*, var. *nigrum*, Gr.); meadow-rue (*Thalictrum dioicum*, L.); blue cohosh (*Caulophyllum thalictroides*, Michx.); wild black currant (*Ribes floridum*, L.); wild gooseberry (*Ribes cynosbati*, L.); and the lousewort (*Pedicularis Canadensis*, L.). This dozen species includes five trees, four of which are of great economic value, the hard maple and the white-oak taking the first places. Among the herbs, the columbine, or the "honeysuckle" of childhood, is the most showy. Boys as well as bees know that sweet is found at the base of each long spur-petal.

It will be seen that fifty-six species bloomed here (Ames, Iowa) during the month of April, or an average of about two and a half per day from April 6th, when the first blossoms of the hepatica were discovered, until the close of the month. The species recorded for May number seventy-seven and for June one hundred and thirty-one. The average for May is the same as for April, but for June it rises to four and one third per day. In July, it is five and a quarter new plants per day, Sundays not excluded. The season of 1886 has been an exceptional one. The spring opened early as the large number of species blooming in April substantially proves. During two months in midsummer there was only a quarter of an inch of rain instead of nine, which is the average. This drought pushed many species forward out of their natural places, and has doubtless much influenced the record.

The flora of the State of Iowa is not very large in numbers. Professor Arthur's catalogue made in 1876 gives nine hundred and seventy-nine species, including well marked varieties. Since 1876 one hundred and ninety-seven additions have been made to the list of flowering plants, thus increasing the total number to eleven hundred and seventy-six. A preliminary list for this county (Story), in which six hundred and nine species and varieties are recorded, has been made the present season by a graduate student, Mr. A. L. Hitchcock, and to whom the writer is indebted for a full and careful record of the time of bloom-

ing of the plants in this vicinity. He was aided by a large class in botany, among the members of which existed a stimulating spirit of rivalry in bringing the first blooms of any species to the class-room. Over fifty observers, therefore, have been gatherers of the facts upon which the present paper is founded.

HATS AS A CAUSE OF BALDNESS.

By W. C. GOUINLOCK.

THE suggestive article in your October number, under the heading "A Bald and Toothless Future," should arouse more than a temporary interest. Of late, frequent reference to baldness has been made in medical and other journals, but none of the articles I have read have given the cause, it seems to me, nor suggested the proper means of prevention. The reasons given are mainly: Wearing a close, warm head-covering, thus rendering the natural one superfluous; the custom of cutting the hair close, living and working indoors, ill-ventilated hats, uncleanliness, and heredity. So many explanations indicate an uncertainty as to the real origin. Is it probable that such a uniform result can be due to so many and diverse causes, some of which must operate in one case and not at all in another?

The habit of wearing warm coverings on the head is not of recent date; the armies of Europe, for instance, no inconsiderable number of men, with heads close cropped, have worn for a long period warmer and heavier head-gear than the modern dwellers in cities, without the same tendency to baldness. Nor are the heavy fur coverings of northern races incompatible with luxuriant hair. It is also difficult to understand what injury can result from close cutting, *per se*. The growth is in the hair-follicle, and in it alone; there is no vital connection between the hair outside the scalp and within; it is usually cut closest at the back of the head and neck, where baldness never occurs. Would not close cutting rather stimulate the growth by exposure of the scalp? Such at least is the popular belief. So, too, with indoor life: women, who ought to show it most, whether in the home or in the factory, are never bald as men are; on the contrary, it is most common with men in good circumstances, as Mr. Eaton's statistics show, men who spend a larger proportion of their daytime in the open air than the indoor worker.

I believe the common form of baldness is due entirely to the kind of hat that is worn, principally to the high hat and the hard felt hat, but also to any other head-covering *that constricts the blood-vessels which nourish the hair-bulbs*. To have a clearer understanding of this, we must remember that the scalp is supplied with blood by arteries at the back, sides, and front of, and lying close to, the skull,

which diminish in size by frequent branching as they converge toward the top of the head. They are in a most favorable position to be compressed, lying on unyielding bone and covered by thin tissue. Consider what effect must be produced by a close-fitting, heavy, and rigid hat: its pressure must lessen to a certain extent the flow of arterial blood, and obstruct to a greater extent the return of the venous; the result being a sluggish circulation in the capillaries around the hair follicles and bulbs, a consequent impairment of nutrition, and final atrophy. This pressure is not trivial or imaginary, as any one will admit who has noticed the red band of congestion on the forehead when a hard hat is removed after moderate exercise. If the man is bald, the red pressure-mark can be seen all around the head.

It may be asked, Can the wearing of a tight band around the head for a few hours a day have any perceptible effect on the growth of the hair? That the hair-bulbs are susceptible to disturbances of nutrition is evident from the effect of a continued fever, or any wasting disease, where nutrition is seriously impaired. They (the hair-bulbs) suffer with the general system; the hair has been starved to death, so to speak, and comes out in large quantities, sometimes amounting to temporary alopecia. If the hair-crop can be thus destroyed by three or four weeks of constant lessened nutrition, it is reasonable to suppose that the same cause, though slight and intermittent, will in time produce the same result.

The course of an ordinary case of baldness corresponds with this view. We observe usually a thinning out of the hair at the poll of the head, or part corresponding to the posterior fontanelle of infancy; a patch appears two or three inches in diameter like the tonsure of a priest. Or, instead, the thinness may begin above the forehead, but in every case, the hair disappears first where the circulation is weakest —that is, along the top of the head, the region most remote from arterial force. The sparseness, at first slight, becomes year by year more apparent, and, finally, a bare and polished surface is presented which gradually descends to the hat-band and there stops. Mark this point, it never goes below the rim of the hat. I admit that the line of denudation does not in some cases correspond exactly with the hat-band; it will be noticed that the coincidence is accurate enough at the back of the head from a point opposite the top of the ear on one side to the corresponding point on the other, but in front of this on either side is often a tuft above the horizontal line that still maintains its growth. The explanation is, that the temporal muscle, occupying the hollow space in the temporal bone, acts as a cushion, thus relieving the pressure on the blood-vessels. In men with rounded heads, full in this region, a continuous line will be observed.

Before leaving this part of the subject I would direct attention to the complete change effected in the scalp after the disappearance of the hair. Unlike the thick, stiff, glandular structure it formerly was,

it is now soft, thin, and flexible, like that of the forehead or other portions of smooth integument. It has lost a distinct anatomical structure; the hair-bulbs and accessories have withered away. Baldness from disease has no choice of location; it occurs irregularly on any part of the head, or affects the whole surface, quite distinct in this respect from the perfectly regular course of hat-baldness. The latter should not be regarded as a disease at all, but rather as an accident of habit.

It does not follow that all persons wearing these objectionable hats must lose their hair. The outline of the head may be irregular, or the blood-vessels may be protected by a thick growth of hair. Close cutting, from this point of view, is injurious, as it allows close contact with the skin. But, few will escape the evil effects of twenty or thirty years of rigid tight-fitting hats, the destructive process being delayed only by the length and frequency of respites from this tourniquet of fashion. I have never seen a person whose habitual head-covering was soft and yielding suffer from baldness. The agriculturist, whose habit it is to wear the loosest head-coverings during the greater part of his life, has usually more hair than is conducive to comfort; but his son who has taken to city life may be bald at thirty. I think it will be noticed that the most rapid cases are among city men with close-cut hair who wear the high hat. It must fit closer, as from its height it is more liable to displacement.

The accuracy with which the hatter plies his trade is skill and energy in the wrong direction. The little instrument, the "conformator," that marks on paper the outline of one's head by which the band is molded to press more uniformly all around, is more destructive of the natural head-covering than ever were the scalping-knives of the North American Indians. It is nothing uncommon to see an old negro, who has taken to high hats, with a bald and shiny pate above and an abundant crop of hair below the hat-rim. I have long been convinced, although history is silent on this point, that old Uncle Ned—

> "Who had no hair on the top of his head,
> In the place where the wool ought to grow"—

was the favored recipient of his master's old silk hats.

Baldness is not confined to race or occupation, but it is to sex. While forty or fifty per cent of middle-aged and elderly city men show some stage of it, women are entirely exempt. They are subject to the same laws of heredity, have the same habits and occupations as men, and yet have as much hair to-day as at any previous time in the world's history. This can only be explained by the essential difference in the head-coverings of the two sexes; and yet the head-gear of women has been condemned and ridiculed in various styles of literature, principally by the high-hat sex. It may not often commend itself to one's sense of utility; it may be at one time a mere nucleus for

brilliant and varied decoration, and at another an expansive and imposing structure, but it has usually the charm of novelty, sometimes of beauty, and it never destroys the growth of hair.

Man's high hat for many generations has varied within very narrow limits, and has always been ugly and unnatural. Why it should so long have held its sway it is hard to understand. An artist can not make it interesting in his work. It will not compare with the Oriental turban, the Scotch bonnet, or even the slouch hat, for comfort or graceful capabilities; but the average man will wear it long after his faith in hair tonics and restorers with seductive promises has been shattered. Still, let him remember, as he takes his after-dinner repose, that his favorite hat will certainly and inevitably extend the pasture-lands of the domestic fly.

AMONG THE TRANSYLVANIAN SAXONS.

I.—MARRIAGE-CUSTOMS.

WHEN the waving surface of the green oat-fields begins to assume a golden tint, when the swelling heads of Indian corn hang heavy on their stalks, and the sweating peasant prepares for the last act of his hard summer labor, then also do the good-wives in the village begin to talk of matters which have been lying dormant till now.

Well-informed people may have hinted before that such and such a youth had been seen more than once stepping in at the gate of the red or green house in the long village street, and more than one gossip had been ready to identify the speckled carnations adorning the hat of some youthful Konrad or Thomas as having been grown in the garden of a certain Anna or Maria; but after all, these had been but mere conjectures, for nothing positive could be known as yet, and ill-natured people were apt to console themselves with the reflection that St. Katherine's Day was a long way off, and that there is many a slip 'twixt cup and lip.

But now the great day which will dispel all doubt, and put an end to surmise, is approaching—that day which will destroy so many illusions and fulfill so few; for now the sun has given the last touch to the ripening grain, and soon the golden sheaves are lying piled together on the clean-shorn stubble-fields, only waiting to be carted away. Then one evening when the sun is sinking low on the horizon, and clouds of dust along the high-road announce the approach of the returning cattle, a drum is heard in the village street, and a voice proclaims aloud that "to-morrow the oats are to be fetched home." Like wildfire this news has spread throughout the village; the cry is taken up and repeated from mouth to mouth with various intonations of hope, curiosity, anticipation of triumph—"To-morrow the oats will be fetched!"

A stranger, no doubt, fails to perceive anything particularly thrill-

ing about this intelligence, having no reason to suppose the bringing in of oats to be in any way more interesting than the carting of potatoes or wheat; and to the majority of land-owners the thought of to-morrow's work is chiefly connected with dry, prosaic details, such as repairing the harness and oiling the cart-wheels; but there are others in the village on whom the announcement has had an electrifying effect, and for whom the words are synonymous with love and wedding-bells.

Five or six of the young village swains, or maybe as many as eight or ten, spend that evening in a state of pleasurable bustle and excitement; busying themselves in cleaning and decking out the cart which is to fetch the oats to-morrow, furbishing up the best harness, grooming the work-horses till their coats are made to shine like satin, and plaiting up their manes with gaudy-colored ribbons. Early next morning the sound of harness-bells and the loud cracking of whips causes all curious folk to rush to their doors; and as every one is curious, the whole population is soon assembled in the street, to gaze at the sight of young Thomas, all attired in his bravest clothes, and wearing a monstrous nosegay in his cap, riding postilion on the left-hand horse, and cracking his whip with ostentatious triumph—while behind, in the gayly decorated cart, is seated a blushing maiden, who lowers her eyes in confusion at seeing herself the object of general attention—at least this is what she is supposed to do, for every well-brought-up maiden ought surely to blush and hang her head in graceful embarrassment when she first appears in the character of a bride; and, although no formal proposal has taken place, yet, by consenting to assist the young man to bring in his oats, she has virtually confessed her willingness to become his wife. Her appearance on this occasion will doubtless cause much envy and disappointment among her less fortunate companions, who peep out furtively through the chinks of the wooden shutters, at this sight of a triumph they had hoped for themselves.

"So it is the red-haired Susanna, after all, and not the miller's Agnes, as every one made sure," the gossips are saying. "And who has young Martin got on his cart, I wonder? May I never spin flax again, if it is not verily the black-haired Lisi who was all but promised to small-pox Peter of the red house!"—and so on, and so on, in endless variety, as the carts go by in procession, each one giving rise to manifold remarks and commentaries, and not one of them but leaves disappointment and heart-burnings in its rear. This custom of the maiden helping the young man to bring in his oats, and thereby signifying her willingness to become his wife, is prevalent only in a certain district in the north of Transylvania, called the *Haferland*—the land of oats—a broad expanse of country covered at harvest-time by a billowy sea of golden grain, the whole fortune of the land-owners.

In other parts of the country various other bridal customs are preva-

lent, as for instance in Neppendorf, a large village in the neighborhood of Hermanstadt, inhabited partly by Saxons, partly by Austrians, or Ländlers, as they call themselves. This latter race is of more recent introduction in the country than the Saxons (who count seven centuries since their emigration), having only come hither in the time of Maria-Theresa, who had summoned them to the country in order to replenish some of the Saxon colonies in danger of becoming extinct. If it is strange to note how rigidly the Saxons have kept themselves from mingling with the surrounding Magyar and Roumanian races, it is yet more curious to see how these two German races have existed side by side for over a hundred years without amalgamating—and this for no antagonistic reason, for they live together in perfect harmony, attending the same church, and conforming to the same regulations, but each preserving its own identical customs and costume. The Saxons and Ländlers have each their different parts of the church assigned to them; no Saxon woman would ever think of donning the fur cap of a Ländler matron—as little would the latter exchange her tight-fitting coat for the wide-hanging cloak of the other woman.

Until quite lately, unions have very seldom taken place between members of these two races. Only within the last twenty years, have some of the Saxon men awoke to the consciousness that the Austrian women made better and more active housewives than their own phlegmatic country-women, and have consequently sought them in marriage. Even then, when both parties are willing, and all preliminaries have been arranged, many a projected union makes shipwreck on the inflexibility of the two fathers, who will neither concede the least trifle to the other's wishes. Thus, for instance, when the Saxon father of the bridegroom demands that his future daughter-in-law should adopt Saxon attire when she becomes the wife of his son, the Austrian father, as likely as not, will take offense, and withdraw his consent at the last moment. Not a pin nor a bow will either of these two consent to sacrifice to their children's happiness. Thus many hopeful marriages have been nipped in the bud, and those few which have been accomplished have been almost invariably based on the understanding that each party retains its own attire, the daughters following the mother, the sons the father, in the matter of costume.

Among the Ländlers, the marriage proposal takes place in a way which deserves to be mentioned. The youth having secretly fixed upon the girl he would like to make his wife, prepares a new silver *thaler* (about 2*s.* 6*d.*) by winding round it a piece of bright-colored ribbon, and wrapping the whole in a clean sheet of white letter-paper. With this coin in his pocket, he repairs to the next village dance, and takes an opportunity of slipping it unobserved into the maiden's hand while they are dancing together. By no word or look does she betray any consciousness of his action, and only when back at home she produces the gift, and acquaints her parents with what has taken place.

A family council is then held as to the merits of the pretendant, and the expediency of accepting or rejecting the proposal. If the latter be decided upon, the maiden must hasten to intrust the silver coin to a near female relation of the young man, who, on receiving it back, is given thereby to understand that he has nothing further to hope in that direction; but if three days have elapsed without the gift being returned, he is entitled to regard this as a consent, and may commence to visit in the house, on the footing of an official wooer. In cases of rejection, it is considered as a point of honor that no word should betray any hint of what has passed to the outside world—a delicate reticence one is surprised to find in these simple folk. This giving of the silver coin is probably a remnant of the old custom of buying the bride, and in many villages it is still usual to talk of the *Braut Kaufen*.

To return, however, to the land of oats, where, after the harvest has been got in successfully, the bridegroom prepares to make fast the matter, or, in other words, officially to demand the maiden's hand of her parents. It is not consistent with village etiquette, however, that the bridegroom *in spe* should apply directly to the father of his intended, but he must depute some near relation, or an intimate friend, to bring forward the request. The girl's parents, on their side, likewise appoint a representative to transmit the answer. These two ambassadors are called the *Wortmacher*, "word-makers"—sometimes also the *Hochzeitsväter*, "wedding-fathers"—and are treated with marked consideration and deference during the wedding festivities.

Much talking and speechifying are required to transact a peasant wedding correctly from beginning to end, and a fluent and eloquent *Wortmacher* is therefore a much-prized individual. Each village has its own set formulas for each of the like occasions—long-winded, pompous speeches, rigorously adhered to, and admitting of neither curtailment nor alteration. The following fragment of one of these speeches will give a correct notion of the general style of Saxon oration.

It is the *Hochzeitsväter* who, in the name of the young man's parrents, speaks as follows: "A good morning to you herewith, dear neighbors, and I further wish to hear that you have rested softly this night, and been enabled to rise in health and strength this morning. And such being the case, I will thank the Almighty for his mercies toward you; and should your health, and the peace and happiness of your household, not be as good as might be desired in every respect, so at least will I thank the Almighty God that he has made your lot endurable, and beg him further to send you in future only so much grief and trouble as you may be enabled patiently to bear at a time. Furthermore, I crave your forgiveness that I have made bold to enter your house thus early in the morning, and trust that my presence herein may in no wise inconvenience you or put you to shame, but that

I may always comport myself with honor and propriety, and that you may have no cause for displeasure in listening to the few words I have come hither to say. It has not remained unknown to me, dearest neighbor, that many years ago you were pleased to enter the holy state of matrimony, taking to yourself a beloved wife, with whom you have lived ever since in peace and happiness; and that furthermore the Almighty God, not wishing to leave you alone in your union, was pleased to bless you, not only with transitory temporal goods, but with numerous offspring—with dearly beloved children—to be your joy and comfort. And among these dearly beloved children is a daughter, who has prospered and grown up in the fear of the Lord to be a comely and virtuous maiden. And as likewise it may not be unknown to you, that many years ago we too thought fit to enter the holy state of matrimony, and that the Lord likewise was pleased to bless our union, not with temporal goods and riches, but with various beloved children, among whom is a son, who has grown up, not in a garden of roses, but in care and toil, and in fear of the Lord. And now this same son, having grown to be a man, has likewise bethought himself of entering the holy state of matrimony, and has prayed the Lord to guide him wisely in his choice, and to give him a virtuous and God-fearing companion. Therefore he has been led over mountains and valleys, through forests and rivers, over rocks and precipices, until he came to your house, and cast his eyes on the virtuous maiden, your daughter. And the Lord having been pleased to touch the hearts of the two young people with a mighty love for each other, they have begged me to come hither to crave your consent to letting them become man and wife."

Probably the young couple have grown up within sight of each other, the garden of the one father adjoining the pig-sty of the other, but the formula must be adhered to notwithstanding, and neither rocks nor precipices omitted from the programme of the speech; and even if the parents of the bride be a byword in the village for their noisy domestic quarrels, yet the little fiction of conjugal happiness must be kept up all the same, with a magnificent sacrifice of veracity to etiquette worthy of any diplomatic newspaper discussing a royal alliance. And, in point of fact, a disinterested love-match among Saxon peasants is about as rare a thing as a genuine courtship between reigning princes. Most often it is a simple business contract, arranged between the heads of the families, who each of them hope to reap advantages from the contemplated alliance. It too often happens that young girls of fifteen, and even younger, having no experience of life or of their own feelings, are persuaded by their parents to give their hand with indifference, or even dislike, to some man whose property happens to fit in conveniently; and when they urge the want of sympathy to the husband proposed, these objections are met by the practical advice of the long-sighted parents: "Try him for a time, and perhaps you will

get to like him; and if not, well, the misfortune is not so great, and it will then be time enough to seek for a divorce."

When the answer to the proposal has been a consent, then the compact is sealed by a feast, called the *Brautvertrinken* (bride-drinking), to which are invited only the nearest relations on either side, the places of honor at the head of the table being given to the two ambassadors who have transacted the business. A second banquet, of a more solemn nature, is held some four weeks later, after the rings have been exchanged in the presence of the pastor.

The 25th of November, the feast of St. Katherine, is in many districts the day selected for tying all these marriage-knots. When this is not the case, then the weddings take place in Carnival, oftenest in the week following the Sunday when the gospel of the marriage at Cana has been read in church, and Wednesday is considered the most lucky day for the purpose. The preparations for the great day occupy the best part of a week in every house which counts either a bride or a bridegroom among its inmates. There are loaves and cakes of various sorts and shapes to be baked, fowls and pigs to be slaughtered—in wealthier houses even the sacrifice of a calf or ox is considered *de rigueur* for the wedding-feast; and when this is the case, the tongue is carefully removed, and, placed upon the best china plate, with a few laurel-leaves by way of decoration, is carried to the parsonage as the customary offering for the reverend *Herr Vater* (the pastor). The other needful provisions for the banquet are collected in the following simple manner: On the afternoon of the Sunday preceding the wedding, six young men belonging to the brotherhood are dispatched by the *Altknecht* from house to house, where, striking a resounding knock on each door, they make the village street re-echo with their cry, "*Bringt Rahm!*"—bring cream. This is an invitation which none durst refuse. All those who belong to that neighborhood are bound to send contributions in the shape of milk and cream, eggs or butter, lard or bacon, to the wedding-houses within their quarter. Every gift, even the smallest one of a couple of eggs, is received with thanks, and the bringer rewarded by a draught of wine.

Next day the women of both families assemble to bake the loaves for the wedding-feast; the future mother-in-law of the bride-elect keeping a sharp lookout on the girl, to note whether she acquit herself creditably of her household duties. This day is in fact a sort of final examination the bride has to pass through, in order to prove herself worthy of her new dignity; and woe to the maiden who is dilatory in mixing the dough or awkward in kneading the loaves! While this is going on, the young men have been to the forest to fetch wood; for it is a necessary condition that the wood for heating the oven where the wedding-loaves are baked should be brought in expressly for this occasion, even if there be small wood in plenty lying ready for use in the shed. The cart is gayly decorated with flowers and

streamers, and the wood conveyed home with much noise and merriment, much in the ancient English style of bringing in the Yule-log. On their return from the forest, the court-yard gate is found to be closed, or else a rope from which are depended straw bunches and bundles, is stretched across the entrance. The women now advance with much clatter of pots and pans, and pretend to defend the yard against the besiegers; but the men tear down the rope and drive in triumphantly, each catching at a straw-bundle in passing. Some of these are found to contain cakes or apples, others only broken crockery or egg-shells. The young men sit up late into the night, splitting up the logs into suitable size for fire-wood. Their duties further consist in lighting the fire, drawing water from the well, and putting it to boil on the hearth. Thus they work till well into the small hours of the morning, now and then refreshing themselves with a hearty draught of home-made wine, the women meanwhile having lain down to rest.

When all is prepared, it is then the turn of the men to take some sleep, and they wake the girls with an old song, running somewhat as follows:

"All in the early morning gray
A lass would rise at break of day.
Arise, arise,
Fair lass, arise,
And ope your eyes,
For darkness flies,
And your true-love will come to-day.

"The lassie would so early fill
Her pitcher at the running rill.
Awake, awake,
Fair lass, awake,
The dawn doth break,
Your pitcher take,
For come to-day your true-love will."

Another song of equally ancient origin is sung the evening before the marriage, when the bride takes leave of her friends and relations:

"FAREWELL-SONG OF THE SAXON BRIDE.

"I walked beside the old church-wall,
My love stood there, but weeping all.
I greeted her, and then she spake:
'Dear love, my heart is like to break.
I must away, I must be gone;
When to return, God knows alone!
When to return?—when the black crow
Bears on its wing plumes white as snow!'

"I set two roses in my father's land—
O father, dearest father, give me again thy hand!

I set two roses in my mother's land—
O mother, dearest mother, give me again thy hand!
I must away, I must be gone;
When to return, God knows alone!
When to return?—when the black crow
Bears on his wing plumes white as snow!

"I set two roses in my brother's land—
O brother, dearest brother, give me again thy hand!
I set two roses in my sister's land—
O sister, dearest sister, give me again thy hand!
I must away, I must be gone;
When to return, God knows alone!
When to return?—when the black crow
Bears on his wing plumes white as snow!

"I set again two roses under a bush of yew—
O comrades, dearest playmates, I say my last adieu!
No roses shall I set more in this my native land—
O parents, brother, comrades, give me once more your hand!
I must away, I must be gone;
When to return, God knows alone!
When to return?—when the black crow
Bears on his wing plumes white as snow!

"And when I came to the dark fir-tree,
An iron kettle my father gave me;
And when I came unto the willow,
My mother she gave me a cap and a pillow.
Woe's me! but those who part can tell
How sharp the pain to say farewell!

"And when unto the bridge I came,
I turned me round and looked back again;
I saw no father nor mother more,
And I bitterly wept, for my heart was sore.
Woe's me! but those who part can tell
How sharp the pain to say farewell!

"And when I came before the gate,
The bolt was drawn, and I must wait;
And when I came to the wooden bench,
They said, 'She's but a peevish wench!'
Woe's me! but those who part can tell
How sharp the pain to say farewell!

"And when I came to the strangers' hearth,
They whispered, 'She is little worth';
And when I came before the bed,
I sighed, would I were yet a maid!
Woe's me! but those who part can tell
How sharp the pain to say farewell!

"My house is built of goodly stone,
But in these walls I feel so lone!
A mantle of finest cloth I wear,
But 'neath it an aching heart I bear.
Loud howls the wind, wild drives the snow,
Parting, oh, parting is bitterest woe!
On the belfry-tower is a trumpet shrill,
But down in the churchyard the dead lie still."

Very precise are the formalities to be observed in inviting the guests. A member of the bride's family is deputed as *Einlader* (inviter), and, invested with a brightly painted staff as insignia of his office, he goes the round of the friends and relations to be asked. It is customary to invite all kinsfolk within the sixth degree of relationship, though many of these are not expected to comply with the summons—the invitation in such cases being simply a matter of form, politely tendered on the one side, and graciously received on the other, but not meant to be taken literally as being but honorary invitations. Unless particular arrangements have been made to the contrary, it is imperative that the invitation, in order to be valid, should be repeated with all due formalities, as often as three times—the slightest negligence or divergence from this rule being severely judged and commented upon; and mortal offense has often been taken by a guest, who bitterly complains that he was only twice invited. In some villages it is, moreover, customary to invite anew for each one of the separate meals which take place during the three or four days of the wedding festivities.

Early on the wedding morning the bridegroom dispatches the *Wortman* with the *Morgengabe* (morning gift) to the bride. This consists in a pair of new shoes, to which are sometimes added other small articles, such as handkerchiefs, ribbons, a cap, apples, nuts, etc. The ambassador, in delivering over the gifts to the *Wortman* of the other party, speaks as follows: "Good-morning, Herr Wortman, and all worthy friends here assembled; the friends from our side have charged me to wish you all a very good-morning. I have further come here to remind you of the laudable custom of our fathers and grandfathers, who bethought themselves of presenting their brides with a trifling morning gift. In the same way our young master the bridegroom, not wishing to overlook this goodly patriarchal custom, has likewise sent me here with a trifling offering to his bride, trusting that this small gift may be agreeable and pleasing to you all." The bride, on her side, sends to the bridegroom a new linen shirt, sewed and embroidered with her own hands. This shirt he wears only twice—once on his wedding-morning for going to church, the second time when he is carried to his grave.

Before going to church all the men assemble at the house of the bridegroom, and the women at that of the bride. The young people

only accompany the bridal pair to church—the elder members of both families remaining at home until the third invitation has been delivered. Then all together proceed to the house of the bride, where the first day's festivities are held. There is much speechifying and drinking of healths, and various meals are served up at intervals of three and four hours' distance, each guest being provided with a covered jug, which must be always kept replenished with wine. It is usual for each guest to bring a small gift or contribution to the newly-set-up household of the young couple, and these are deposited on a table spread for the purpose in the center of the court-yard; or, if the weather be unfavorable, inside the house, bride and bridegroom standing on either side to receive the gifts. First it is the bridegroom's father who, approaching the decorated table, deposits thereon a new shining plowshare, as symbol that his son must earn his bread by the sweat of his brow; then the mother advances with a new pillow, adorned with bows of colored ribbon, and silver head-pins stuck at the four corners. These gay adornments are meant to represent the pleasures and joys of the married state; but two long streamers of black ribbon, which hang down to the ground on either side, are placed there likewise, to remind the young couple of the crosses and misfortunes which must inevitably fall to their share. The other relations of the bridegroom follow in due precedence, each with a gift in his hands. Sometimes a piece of home-made linen, a colored handkerchief, or some other article of dress or decoration; sometimes a roll of sheet-iron, a pair of scissors, thread and needles, a packet of nails, or a farming or gardening implement, each one laying down his or her offering with the words, "May it be pleasing to you." Then follow the kinsfolk of the bride with similar gifts; her father presenting her with a copper caldron or a kettle, the mother with a second pillow, decorated in the same manner as the first one. Playful allusions are not unfrequently concealed in these gifts—a doll's cradle, or a young puppy-dog wrapped in swaddling-clothes, often figuring among the presents ranged on the table.

Various games and dances fill up the pauses between the meals; songs and speeches, often of a somewhat coarse and cynical nature, being a part of the usual programme. Among the games enacted at some of the Saxon peasant-weddings there is one which deserves to be mentioned, affording as it does a curious proof of the tenacity of old pagan rites and customs, transmitted by verbal tradition from one generation to the other. This is the *Rössel Tanz*, or dance of the horses, evidently founded on an ancient Scandinavian legend to be found in Snorri's "Edda." In this tale, the gods Thor and Loki came to a peasant's house in a carriage drawn by two goats or rams, and asked for a night's lodging. Thor killed the two rams, and with the peasant and his family consumed their flesh for supper. The bones were then ordered to be thrown in a heap onto the hides of the ani-

mals; but one of the peasant's sons had, in eating, broken open a bone, in order to get at the marrow within, and next morning when the god commanded the goats to get up, one of them limped on the hind-leg, because of the broken bone. At first Thor was in a great rage, and threatened to destroy the whole family, but finally allowed himself to be pacified, and accepted the two sons as hostages.

In the peasant drama we have now before us, the gods Thor and Loki are replaced by a colonel and a lieutenant-colonel, and, instead of two goats, there are two horses and one goat; also the two sons of the peasants are here designated as Wallachians. Everything is of course much distorted and changed, but still all the principal features of the drama, which space forbids me here to enlarge upon, are clearly recognizable—the killing of the goat and its subsequent resurrection, the rage of the colonel, and the transferment of the two Wallachians into his service, being all parts of the performance.

At midnight, or sometimes later, when the guests are about to depart, there prevails in some villages a custom which goes by the name of *den Borten abtanzen*—dancing down the bride's crown or head-dress. This head-covering, which can only be described as resembling a chimney-pot hat without brim or crown, and from which depend long streamers of ribbon reaching to the ground, is the sign of her maidenhood, which she must lay aside now that she has become a wife, and it is danced off in the following manner: All the married women present, except perhaps a few very old and decrepit ones, join hands, the two brideswomen taking the bride between them. Thus forming a wide circle, they dance backward and forward, round and round the room, sometimes forming a knot in the center, sometimes far apart with outstretched arms, till suddenly, either by accident or on purpose, the chain is broken through at one place, which is the signal for all to rush out into the court-yard, still holding hands. From some dark corner there now springs unexpectedly a stealthy robber, one of the bridesmen, who has been lying there in wait to rob the bride of her crown. Sometimes she is defended by two brothers or relations, who, dealing out blows with twisted handkerchiefs or towels, endeavor to keep the thief at a distance; but the struggle always ends with the loss of the head-dress, which the young matron bewails with many tears and sobs. The brideswomen now solemnly invest her with her new head-gear, which consists in a snowy cap and veil, held together by silver or jeweled pins, which are sometimes of considerable value.

When the young couple go to church the day after the wedding, they are met at the church-door by a group of masked figures who surround them, singing and hooting, and playfully endeavor to separate the young matron from her husband. If they succeed in so doing, then he must win her back in a hand-to-hand fight with his adversaries, or else he must give a piece of money as her ransom. In general

it is considered a bad omen for the married life of the young couple if the wife be separated from her husband on this occasion; therefore it is customary for the young husband to take his stand close by the church-door while his wife is praying within, and then be ready to catch hold of her as soon as she steps outside. For greater precaution, the man often holds her round the waist with both hands during the dance which immediately takes place before the church, and at which they assist merely as spectators, taking no active part, as it is not considered seemly to dance in the church attire.

As commonly several couples are married at the same time, it is usual for each separate wedding-party to bring its own band of music, and dance thus independently of the others. On the occasion of a triple wedding I lately witnessed, it was very amusing to watch the three wedding-parties coming down the street, each accelerating its pace till it came to be a sort of race up to the church-door to secure the best dancing-place. The ground being rough and slanting, there was only one spot where anything like a flat dancing floor could be obtained, and the winning party at once secured this enviable position, while the others had to put up with an inclined plane or a few hillocks accidenting their ball-room floor. The ten to sixteen couples belonging to each wedding-party are inclosed in a ring of bystanders, each rival band of music playing away with heroic disregard for the scorched ears of the listeners. "Polka!" calls out the first group; "*Walzer!*" roars the second, for it is a point of honor that each party should display a noble independence in taking its own line of action; and if, out of mere coincidence, two of the bands happen to strike up the self-same tune, one of them is sure to change to something totally different as soon as aware of the unfortunate mistake—the caterwauling effect produced by this system baffling all description. "This is nothing at all," said the worthy pastor, from whose garden I was overlooking the scene, laughing at the evident dismay with which I endeavored to stop my ears. "Sometimes we have eight or ten weddings at a time, each with their own fiddlers. That is something worth hearing indeed!" The rest of that day is spent much in the same manner as the former one, only this time in the house of the bridegroom's parents.

Among the customs attached to this first day of wedded life is that of breaking the distaff. If the young matron can succeed in doing so at one stroke across her knee, then she will be sure to have strong and healthy sons. If the reverse, she has only girls to expect.

The third day is called the finishing-up day, each of the two families assembling its own friends and relations to consume the provisions remaining over from the former banquet, and at the same time to wash up the cooking-utensils and the crockery, restoring whatever has been borrowed from neighbors in the shape of plates, wine-jugs, etc., the new-married couple joining the entertainment, now at the one,

now at the other house. This day is the closing of the wedding festivities, which have kept both families in a state of unusual bustle and excitement for fully a week. Everything now returns to every-day order and regularity, the young couple usually taking up their abode in a small back-room in the house of the young man's parents, and putting off till the following spring the important business of setting to build a house of their own. Dancing and feasting are now at an end, and henceforward the earnest of life begins.—*Blackwood's Magazine.*

[*To be continued.*]

WILLIAM BABCOCK HAZEN.

By Professor CLEVELAND ABBE.

THE sudden death of Brigadier-General William B. Hazen, Chief Signal-Officer of the United States Army, which occurred on Sunday, January 16, 1887, deprived the country of one of its most distinguished officers, and the Signal Corps of a chief who took a broad view of its duties and relations to the world of business and science.

General William Babcock Hazen was the great-grandson of Thomas Hazen, who was born in 1719, and who was himself great-grandson of Edward Hazen, who emigrated from England before 1649, and settled at Rowley, Massachusetts, where he died in 1683.

The descendants of Edward Hazen include many names eminent in business, theology, and war; energy, industry, and strong convictions characterize the members of the family on all sides.

General Hazen was born at West Hartford, Vermont, September 27, 1830. While he was yet a child, his parents removed to Hiram, Portage County, Ohio. In 1851 he was appointed from Ohio as a cadet to the United States Military Academy at West Point, from which he graduated July 1, 1855. He was assigned to the Eighth United States Infantry, and spent the next five years in frontier service, more especially against the Indians in California, Oregon, and Texas, in which service he displayed an energy and bravery that have been characteristic of his life. His record during these years embraces constant fights and pursuits. He was twice severely wounded; and, by virtue of the latter, he was, in January, 1860, by the surgeon's order, granted a leave of absence as being unfit for duty. In consequence of this, he was at the North while his regiment was in Texas at the breaking out of the rebellion; the regiment having been captured and its officers released on parole, he alone was unembarrassed by the parole, and was able to offer his services to the Union army. He was at once assigned as temporary instructor at West Point. In May, 1861, he became captain of the Eighth Infantry, of the regular army, and in October was made colonel of the Forty-first Regiment of Ohio Infantry in the

volunteer army. During the war he distinguished himself on many occasions, and his commission as major-general was granted him December 13, 1864, for "specific distinguished services"—i. e., "for long and continued services of the highest character, and for special gallantry and service at Fort McAllister." This placed him fifth in a list of twenty-four officers who had received commissions for distinguished service.

He continued serving on the frontier territories, north and west, and was especially active in Indian affairs until 1870, in which year he was allowed leave of absence to visit the seat of war in Europe. The results of his observations and studies during his six months' absence are embraced in a volume entitled "The School and the Army in Germany and France, with a Diary of Siege-Life at Versailles," New York, 1872. This volume contains a very interesting sketch of Bismarck and Bismarck's own account of the state of affairs in Europe. It contains especially a fair criticism of the relative excellencies of the German and French systems, both civil and military; in a special chapter on that subject, he incidentally brought out more prominently some weak points in our own military organization. It would seem that the courage displayed so brilliantly on the battle-field frequently nerved him to utter not only these but other fearless criticisms of things that were palpably wrong, and some of which have since been corrected.

He was married February 15, 1871, to Millie, daughter of the Hon. Washington McLean, of Cincinnati, who with one son survives him.

On his return from Europe in 1871, he returned to duty in the Indian Territory, and was with his regiment in Kansas and Dakota, except for a short absence, until December 15, 1880, when he was by President Hayes appointed brigadier-general and chief signal-officer, and since then has been stationed at Washington. The absence just referred to was occasioned by his again visiting Europe as military *attaché* to the United States legation at Vienna, for the purpose of studying the operations of European armies during the Turco-Russian war. He was absent on this service from December, 1876, to June, 1877, and the results of his observations were published subsequently in a highly interesting popular volume.

The general account of his activity during the war of the rebellion was published by him in his "Narrative of Military Service," Boston, 1885.

His letters and pamphlets on the "Bad Lands" show that for many years General Hazen had been studying the relations of meteorology and agriculture; upon his appointment as chief signal-officer he became indefatigable in his efforts to improve the military and departmental relations of the Signal Service, its scientific character, its practical usefulness to farmers and herders, and its popular influence. His labors in Washington stirred up most virulent opponents—first, when

it became necessary for him to expose and prosecute the corruption of Captain Howgate; again, when it became necessary in self-defense to expose the true reasons of the failure of the War Department to properly support and succor the Signal-Service Expedition to Fort Conger; and, again, when he had occasion to defend the advantages of the military character of the combined Signal Service and Weather Bureau organization against those who would take it from the army without making a proper provision for its work in any other department. The records of his successful defense against attacks prompted by implacable hate, official stubbornness, and personal ignorance are to be found in the proceedings of "Courts-Martial," "Courts of Inquiry," "Committee of Congress on Expenditure," and especially in the "Testimony before the Joint Commission to consider the Present Organization of the Signal Service," etc., which latter voluminous report with testimony was printed in June, 1886.

General Hazen's interest in meteorology, as before said, properly dates back earlier than 1873, at which time he prepared a letter "On our Barren Lands, or the Interior of the United States, west of the One Hundredth Meridian and east of the Sierra Nevadas." This was published in the "New York Tribune," February 27, 1874, and led to a discussion in that paper and in the "Minneapolis Tribune" between himself and General A. A. Custer, which is summarized in a pamphlet of the above title published by Robert Clarke & Co., of Cincinnati, in 1875. The motive of General Hazen evidently was the protection of investors and settlers against the too glowing accounts, which amounted to virtual misrepresentation, on the part of the employés of the Northern Pacific Railroad; his compilation of climatological data, and his statement of personal experience, based on long residence in that region, largely contributed to prevent blind emigration into an inhospitable country, while they doubtless also contributed to direct attention to the really valuable portions of our Northwest territory, so that the permanent development of that portion of the United States has been furthered by his action. It was, however, at the time, on his part, a very characteristic, outspoken exposition of what seemed to him a fraud and imposition perpetrated by unscrupulous financiers upon foreign immigrants and over-confiding settlers and investors.

During his connection with the Signal-Office, General Hazen frequently took occasion to show his appreciation of the fact that the weather predictions were essentially not a matter of mere military routine, but that in all departments the office had need of the work of specially trained experts; that it was a mistake to shut one's eyes to the fact that, in a matter of applied science like this, some of those whom the scientific world recognizes as meteorologists and physicists must be employed and be required to keep the chief fully informed of the progress of science. Perhaps this is best exemplified by a quotation from his letter of March 24, 1886, addressed to a Committee of

the House on Expenditures of the War Department: "At the beginning of the work of the Signal Service, the duty of giving notice of the approach and force of storms and floods for the benefit of commerce and agriculture throughout the United States implied that the notices should be correct, reliable, and timely, as none others could possibly be of benefit; it was, therefore, absolutely necessary to provide for the careful study of the atmosphere. On my accession, I found every evidence, from popular criticism, that still further progress in weather predictions was expected. I therefore emphasized especially the necessity of the study of the instruments and methods of observing and the investigation of the laws of the changes going on in the atmosphere. . . . It is evident by these successive steps that, in addition to knowledge gained for current work, the office is powerfully contributing toward the establishment of a deductive science of meteorology which will eventually give us a solid, rational basis for predictions, thereby improving on the empirical rules by which predictions have generally been made hitherto." And he adds that he was led more especially to assist in the researches on the sun's heat by reason of the encouragement given him by the late President Garfield, whose "last words to me were, 'Give both hands of fellowship and aid to scientific men.'"

As a further illustration of General Hazen's appreciation of the scientific needs of the office, must be noted his appointment of Professor William Ferrel as meteorologist, and of Professor T. C. Mendenhall as electrician; to the latter, all matters relating to standards, instruments, and instrumental research were also committed. Nor did he stop here, but, by appointing several younger men to positions as junior professors, he largely increased the amount of study and research that the office was able to perform, and, by publishing a series of professional papers and smaller notes, he took the final steps necessary to stimulate every man to do his best. Laboring in this same direction, he sought to elevate the intelligence and scientific training of the Signal Corps proper, by enlisting college graduates as far as possible, by extending the course of instruction for observers, and by establishing a course of higher instruction for commissioned officers.

In still another direction General Hazen showed his affiliation with scientific interests, namely, by his desire to conform as thoroughly as possible to the recommendations of the International Meteorological Conferences. These recommendations, as soon as received in the printed minutes of the conferences, were, by General Hazen's orders, carefully examined, and instructions at once prepared calculated to introduce methods of observation and publication in conformity with the recommendations of the leading meteorologists of the world.

Among the items specially noteworthy, wherein General Hazen de-

veloped new paths of activity for this service, may be mentioned the study of local thunder-storms and tornadoes, which were respectively assigned to Professor Hazen and Lieutenant Finley so far as a collection of general statistics is concerned; and to Professor Mendenhall, so far as concerns the electrical phenomena proper. The study of atmospheric electricity was especially authorized in 1884, by an order of the Secretary of War, transmitting the resolutions of the International Electrical Conference held in Paris the preceding year. After full consultations with numerous electricians throughout the country, General Hazen decided that a daily map of electric potential showing lines of equi-potential similar to the iso-barometric lines, offered hopeful prospect of eventually leading to a method of predicting the formation and motion of thunder-storms and tornadoes. But the methods of observation, and the apparatus, needed first to be determined upon, after careful experimental work. This whole matter was, therefore, in 1885, committed to the hands of Professor Mendenhall.

Perhaps the most important item in internal administration, so far as it affects the permanent scientific value of the office-work, was the effort heartily furthered by General Hazen to improve the accuracy and international comparability of our instrumental equipment. The standards of the International Bureau of Weights and Measures were recognized by him as being the proper legal standards for this office, and every effort made to determine the corrections needed to reduce the past as well as the current meteorological observations of the Signal-Service to agree therewith.

Perhaps the generous breadth of General Hazen's views, the absence of injurious jealousies, and his confidence in the principle that the Weather Bureau would be strengthened by the widest diffusion of an intelligent appreciation of meteorology, are in nothing more clearly shown than in the earnestness with which he stimulated the formation of state weather services, and encouraged the study of meteorology in every school and college. He was painfully impressed by the disastrous influence upon individuals and business of the wide-spread and utterly absurd predictions of the storms and weather of March 9, 1884, which were distributed broadcast throughout the country, and emanated from Mr. Vennor. He saw clearly that all this harm could only be prevented by increasing the intelligence of the people in scientific matters, and heartily indorsed every effort to diffuse a more correct idea as to what constituted legitimate meteorology.

Although his duties demanded the maintenance of a great central office at Washington, yet General Hazen realized that centralization could easily be carried too far in scientific matters, and would thus react injuriously upon the work of his office. He was desirous of rapid progress in all directions, and, to secure this, welcomed every prospect of co-operation with other institutions as well as with individ-

uals. One of his first acts was the request for co-operation on the part of the National Academy of Sciences. He improved the opportunity to help Professor Langley in the determination of the absorbing power of the atmosphere ; he accepted Professor King's offer to carry observers on his balloon-voyages ; he heartily furthered Lieutenant Greely's efforts to maintain an international polar station, and joined with the Coast Survey in establishing a similar station, under Lieutenant Ray, at the northern point of Alaska ; he co-operated with the Bureau of Navigation in securing weather reports from the ocean; he powerfully assisted the Metrological Society in its labors for the reformation of our complicated system of local times, the result of which was the adoption by the country of the present simple system of standard meridians one hour apart.

Equally successful was he in his efforts to co-operate in various methods of disseminating and utilizing the knowledge obtained by the Weather Bureau for the benefit of the business interests of the country. With the telegraph companies he published the daily telegraph bulletin. Through the railroad companies he displayed the railroad train-signals visible to every farmer along the railroads. With local boards of trade and other business interests he elaborated our system of flood-warnings in the river-valleys.

General Hazen was especially clear in his views as to the importance of giving personal credit to each man for his own personal work. Routine work was credited to the assistants in charge and not to the impersonal office; having assigned a special work to the best man available, he took pains to give him the credit and make him personally responsible for its success, thus securing more enthusiasm in the work.

This notice of a few prominent features in the intense activity of General Hazen's life seems eulogistic rather than historical; but to the contrary, the fact is that military life rarely offers a position that requires the promotion of any special science, and still more rarely do official or military circles present an officer who so thoroughly desired, as far as allowable, to relax stringent military law and liberally interpret cumbersome official regulations, so that scientific men might successfully promote their special work.

M. GRAND 'EURY has propounded a theory that coal was originally a liquid generated by the decomposition of inferior vegetation in an atmosphere highly charged with carbonic acid. The carbon of the jelly-like mass thus formed, after passing through various transformations into asphalt, petroleum, bitumen, etc., finally assumed the form of coal. The author cites various facts connected with the occurrence of coal, which, he thinks, are better explained on his theory than by the usual one.

SKETCH OF JAMES FERGUSSON.

MR. JAMES FERGUSSON, writer on architecture and its history, who died January 9, 1886, was distinguished for the diligence with which he prosecuted his researches, and for the originality of his conclusions. Although the subject to which he chiefly directed his attention is usually classed among the arts rather than the sciences, he brought so philosophical a spirit to its study; so prominently regarded it in its archæological and anthropological aspect, and so combined with the questions which it raised those which relate to the development of human civilization; and so faithfully in all his work upon it strove, as he expresses the thought, to raise its study from the "dry details of measurements to the dignity of an historical science," that he may well be considered entitled to a place among scientific men.

Mr. FERGUSSON was born at Ayr, in Scotland, in 1808, the son of an army-surgeon, who had seen active service abroad, "who had a liking for engineering as applied to architecture," and who wrote on the construction of hospitals. He was taught in the High School at Edinburgh and in a private school at Hounslow, and became a resident of England by the removal of his father to Windsor. When he had reached an age to start out for himself, he went to India, with a determination to work steadily in business for ten years, and then to retire with such fortune as he might have been able to make. He associated himself with a mercantile house in Calcutta, from which he withdrew his interest in time to escape being involved in its failure, and afterward, having filled for a short time two or three administrative positions, became an indigo-planter in Bengal.

He had, however, already developed a high interest in art, and found in India an attractive field, and novel in many of its features, for the cultivation of this taste and the increase of his knowledge. He made a thorough exploration of the whole peninsula, traveling, for the most part, on camel-back, and armed with a *camera lucida*, with which he was an expert draughtsman. His attention was directed early to the rock-cut temples of Ajunta, Ellora, and other places. "His perspicacity," says a critic of his life in the "Athenæum," "soon guided him to a true explanation of the origin and character of these remains, his familiarity with Indian life and modes of worship gave insight as to the intentions of the excavators, and large comparisons enabled him to decide on the positive as well as the relative ages of these astonishing works. . . . In effect, the first fruit of his researches was a denial that the temples were architectural at all in the ordinary sense of that term." His first publication of the results of these studies was the "Illustrations of the Rock-cut Temples of India," which appeared in

1845. It was followed, in 1847, by "Picturesque Illustrations of Ancient Architecture in Hindostan," and at later dates by contributions to the works of Captain Hart, Mr. Hope, and Meadows Taylor, on special or local features in the architecture of India. Another work connected with this subject may be mentioned here—"Archæology in India," published in 1884, which was called forth by strictures on his views, and had much of the controversial in its composition. Mr. Fergusson's studies on these subjects, which he believed were prosecuted under singularly favorable circumstances, assumed such a character that he could say: "Not only was I able to extend my personal observations to the examples found in almost all the countries between China and the Atlantic shore, but I lived familiarly among a people who were still practicing their traditional art on the same principles as those which guided the architects of the middle ages in the production of similar but scarcely more beautiful or more original works. With these antecedents, I found myself in possession of a considerable amount of information regarding buildings which had not previously been described, and—what I considered of more value—of an insight into the theory of the art, which was certainly more novel." On the strength of this knowledge he published, in 1849, "An Historical Inquiry into the Principles of True Beauty in Art, with Especial Reference to Architecture." The book was not written in a popular style, and did not sell. The matter of this essay was afterward written over in a more engaging style, into the "Illustrated Hand-Book of Architecture," a concise and popular account of the different styles prevailing in all ages and countries, which was published in 1855. This book was successful. Having gone out of print, it was again rewritten in an entirely new form, and the result of the remodeling appeared in 1865, as the "History of Architecture in All Countries from the Earliest Times to the Present Day," in three volumes, afterward enlarged into four. This book is described by a critic in the "Academy" as practically standing "quite alone in the English language as an encyclopædia of architecture; and though its immensely wide scope necessarily forced its author to depend largely on the drawings and statements of others, and so caused many inaccuracies to creep into the text, yet on the whole it is a work of real and, to all appearance, lasting value." The purpose of the work was declared to be to write a universal history of architecture, in which each style shall occupy exactly that amount of space which the extent of the buildings or their merit would appear to justify; and to apply one law of criticism to all styles, ancient and modern, Eastern and Western, showing why one building has been successful or another failed, by a reference to those principles of design in architecture which seem to be universal and are easily understood. While the method of the "Hand-Book" was topographical, the historical method was adopted in the "History" as the one better suited to the purposes of giving a general view of the whole of the subject, and of

tracing the connection of the various parts with one another. A great deal had recently been added to knowledge on the subject by the publication of special treatises in particular departments of it, and photography and the careful study of ancient monuments and buildings had furnished means of reaching more correct conclusions. Stress was laid on this last point, for so long, the author said, as our researches are confined to what the ancient authors have written, "many important problems remain unsolved, and must ever remain as unsolvable as they have hitherto proved"; and in the countries and times to which the monuments appertained, "men who had a hankering after immortality were forced to build their aspirations into the walls of their tombs or of their temples. Those who had poetry in their souls, in nine cases out of ten expressed it by the more familiar vehicle of sculpture or painting rather than in writing. To me it appears that to neglect these in trying to understand the manners and customs or the history of an ancient people, is to throw away one half, and generally the most valuable half, in some cases the whole, of the evidence bearing on the subject."

In the second edition of the "History," which was published in 1874, Mr. Fergusson called attention to the need of a comprehensive and systematic study of American architecture, saying: "What is really wanted is that some one should make himself personally acquainted with all the various styles existing between the upper waters of the Colorado and the Desert of Atacama to such an extent as to be able to establish the relative sequence of their dates, and to detect affinities when they exist, or to point out differences that escape the casual observer. . . . The problem is, in fact, identical with that presented to Indian antiquaries some thirty years ago. At that time we knew less of the history of Indian architecture than we now know of American, but at the present day the date of every building and every cave in India can be determined with absolute certainty to within fifty, or at the outside one hundred, years; the sequence is everywhere certain, and all can be referred to the race and religion that practiced that peculiar style. . . . What has been done for India could, I am convinced, easily be accomplished for America, and with even more satisfactory and more important results to the history and ethnography of that great country. The subject is well worthy the attention of any one who may undertake it, as it is the only means we now know of by which the ancient history of the country can be recovered from the darkness that now enshrouds it, and the connection of the Old World with the New—if any existed—can be traced, but it is practically the only chapter in the history of architecture which remains to be written."

Mr. Fergusson had intended to include in his "History" chapters on what were known as Celtic or Druidical remains. But, when the subject came to be looked into, it was found that the whole was such

a confused mass of conflicting theories and dreams, that no facts or dates were so established that they could be treated as historical. The materials which had been collected on this subject were, therefore, worked into another book, which appeared in 1872, as "Rude Stone Monuments." Its character was rather argumentative than historical; it presented the view that the style of architecture to which the monuments described belong "is a style, like Gothic, Grecian, Egyptian, Buddhist, or any other. It has a beginning, and middle, and an end; and though we can not make out the sequence in all its details, this at least seems clear—that there is no great hiatus; nor is it that one part is historic, while the other belongs to prehistoric times. All belong to the one epoch or the other. Either it is that Stonehenge and Avebury, and all such, are the temples of a race so ancient as to be beyond the ken of mortal men, or they are the sepulchral monument of a people who lived so nearly within the limits of the true historic times that their story can easily be recovered." The author's belief was that they were of Roman and post-Roman times. These conclusions were disputed; Sir John Lubbock pronounced some of them hasty and untenable, and some seemingly inconsistent with one another; but for all that he accorded the book "the merit of being a rich and trustworthy storehouse of facts." Another critic, Mr. S. P. Oliver, while he accepted Sir John Lubbock's verdict, predicted that the book would doubtless become a text-book on that section of archæology which pertains to megalithic structures.

In his treatise on "Tree and Serpent Worship," which was published in 1868, and in a second edition in 1873, Mr. Fergusson, availing himself of the results of his laborious researches in India, presented some original views respecting the symbolism of the ancient religions, and the primitive conceptions from which they may have arisen.

Another line of work in which Mr. Fergusson distinguished himself by his diligence and the novelty of some of his conclusions was that of Jewish, Assyrian, and classical antiquities, the fruits of his studies in which were presented in a variety of publications and shapes. In the "Topography of Jerusalem" he set forth some theories in regard to the true site of the temple which appear to have been set aside by later explorations. This was followed by other papers and articles respecting Jerusalem and its sites. In "The Palaces of Nineveh and Persepolis restored" he attempted an exposition of the architecture of Western Asia from the earliest period to the age of Alexander. By papers and suggestions he advised and assisted Sir Henry Layard in restoring the plans and explaining the designs of the temples of Nineveh; and he did a like service for Dr. Schliemann in unraveling the plans of Troy, Mycenæ, and Tiryns. The value of these services was freely acknowledged by Dr. Schliemann, who, dedicating his "Tiryns" to him, styled him "the historian of architecture, eminent alike for his

knowledge of art and for the original genius which he has applied to the solution of some of its most difficult problems." He studied the manner in which the Parthenon (and presumably other ancient temples) was lighted, and came out with a conclusion different from any which had been currently held before. It had been supposed that the lighting of the building was hypæthral — that is, through an opening in the roof; Dr. Fergusson maintained that the light was admitted through side-openings, like the clearstory of a cathedral, while the sun and rain were excluded; and the last work he published—"the Parthenon"—presented the considerations in favor of this view.

From 1863 to 1866, Mr. Fergusson was, with the exception of the year 1872, a member of the Council of the Royal Geographical Society. When filling this office, says Major-General Sir Frederick Goldsmid, his advice and assistance, always tendered with readiness, were of a most useful and practical kind, whether in advancement of the science to which the society was dedicated, or in minor details connected with the buildings in which its deliberations were held. In this society he was more frequently heard in participation in the discussions than in the reading of papers; but one of his papers, "On the Delta of the Ganges and the Natural Law regulating the Course of Rivers," was pronounced a most original and valuable contribution to science.

He bestowed much attention on military engineering and fortification. He set forth as early as 1849, in his "New System of Fortification," the advantages of earthworks as defenses against artillery, which have since been conclusively proved many times in real battle. He was appointed, in 1857, a member of the Royal Commission to inquire into the defenses of the United Kingdom; and he afterward served for eight months, or till the retirement of his chief, as assistant to Sir Henry Layard, Chief Commissioner of Public Works.

Regarding the value of Dr. Fergusson's work, we have the carefully measured estimate in the "Athenæum," that "his acute analysis and criticism, always intended to illustrate the perfection of common sense, did not invariably carry conviction; . . . yet his clear, laborious, and searching methods commanded attention, and never failed to gain respect. Those who could not agree with his views upon the beauty and æsthetic value of Indian architecture, nor accept his version of the history of the holy places at Jerusalem, acknowledged the authority of his masterly and careful studies of whatever kind."

CORRESPONDENCE.

"FUNCTIONS OF THE STATE."

Editor Popular Science Monthly:

THOUGH usually reading with approbation the "Editor's Table" in "The Popular Science Monthly," I can not refrain from expressing a decided dissent from the position taken in the latter part of an editorial in the March number entitled "Functions of the State." The opinion therein advanced is that "education is no part of the functions of the State, and that it would be better, therefore, to leave it in the hands of the family, even though the result were to show in the course of a few years a larger proportion than now of that kind of illiteracy which consists in not being able to read or write." In other words, as I understand the editor's meaning, he would do away with our present public-school system, now regarded by educators and tax-payers generally as the most effective means of promoting popular education, and substitute therefor a *laissez-faire* or go-as-you-please system of private education. That is certainly a revolutionary proposition. Is it logical or tenable?

The theory of the common-school system, by which the wealthy (tax-payers) are made to bear the burden of educating the children of the poor, is, of course, that under this system more children are taught the rudiments of knowledge, and that this teaching is, as a whole, more effective than would be the case if the matter were left to individual action; that is, that more knowledge is imparted to the people in a given time than would be possible by any other means. Back of this is the more fundamental assumption that knowledge is good; that as the antagonist of ignorance it is also the enemy of crime and disorder. Can the truth of either of these propositions be successfully disputed?

It needs no figures to prove that ignorance is the mother of crime. It is a part of the common experience of every man. The patrons of bar-rooms, the criminal classes in city and country, the inmates of prisons, are, as a rule, the uneducated. Educate the children of these people, teach them the great lesson that happiness, prosperity, and success depend upon right living (to the establishment of this truth all true education tends), and you decrease crime.

Again, can it be denied that anatomical and physiological ignorance is the parent of disease? Or that ignorance of political economy gives birth to financial heresies, to the enactment of unjust or unwise laws, to mistaken ideas concerning real-estate tenure, to socialism, communism, and anarchism?

If it be admitted, then, that the spread of knowledge is conducive to the public weal, the only question remaining is as to the efficacy of the present school system to that end. And here, again, it is not necessary to appeal to statistics to prove that a large majority of the people in any country would be pecuniarily unable to educate their children without some form of State aid. And of those who could afford it a large fraction would lack the disposition to do so. It must be evident to any observer that were all laws relating to instruction at public expense to be repealed, and the entire matter left to the individual, popular schooling would become a thing of the past. Illiteracy among the masses would be the rule, and education would be confined to a comparative few among the well-to-do. A well-defined educated class would gradually be formed, and a class spirit would be fostered contrary to the central idea of a democratic society. The brotherhood of cranks would increase and multiply, all kinds of isms would flourish and become powerful, and especially the "labor element," with its demands, would assume the proportions of a national danger, and perhaps succeed in time in bringing about revolution and anarchy.

I think I have not put the case too strongly. That our present educational methods are in many respects faulty, and that there is urgent need of reform in the manner in which the theory of public education is put in practice, I do not deny. The wisdom of compulsory educational laws may be questioned. But it seems to me plain that the theory itself is based upon correct scientific principles. If there is any public function which an organized society is justified in performing, it is to take measures for the elimination of elements within itself inimical to its own existence. And the surest and cheapest way to accomplish this is to disseminate the simple branches of knowledge among its young, to an extent that will inspire them with a desire for higher truth, and furnish them with a sufficient mental equipment for its acquirement and digestion. E. S. MARSH.

BRANDON, VERMONT, *February* 28, 1887.

A CORRECTION.

Editor Popular Science Monthly:

SIR: In your March issue you say, referring to my article on socialism, in the January "Scribner": "He apparently ap-

proves of the exemption of church property from taxation, in so far as the practice is grounded on a belief that the interests of public order will thereby be subserved."

I do not see why you should say this. There is nothing in my article to justify it. That article was written, not to discuss church exemption, but to define and illustrate socialism. Church exemption was only referred to so far as to answer the inquiry, Is it socialistic? Now, my definition of a socialistic measure—say, a legislative act—makes the motive and the objective a part of the act, equally with the positive provisions thereof; and by that definition, the exemption of church property from taxation, with a view to the promotion of good order, the reforming of vice and violence, the security of property, is not socialistic. It may be unwise; it may be monstrously foolish. On that point I had nothing to say, because I was writing on socialism. You express "surprise" that I should mention the argument in favor of church exemption, without denouncing it as hollow, unscientific, and a manifest begging of the question. Pardon me for suggesting that, whatever may be true of journals of art or theology, a journal maintained in the interests of science should encourage writers in sticking to their subjects, for the time being, and not going off erratically to discuss —much less, to denounce—views which regard matters wholly outside their chosen field of inquiry. Having decided that the measure in question was not socialistic, I had nothing more to do with it in an article on socialism.

It was perfectly competent to "The Popular Science Monthly" to reject my definition of socialism; but it should not blame me for adhering closely to that definition, when once adopted. Respectfully, yours,

FRANCIS A. WALKER.

BOSTON, *March* 18, 1887.

We publish the above letter as a matter of simple justice to its author. It seems that we put a wrong construction on that portion of his article in the January "Scribner" dealing with the question of the non-taxation of church property. All we can say is that we gave his article a tolerably attentive reading at the time, and understood him to give at least an implied approval of the policy of non-taxation, provided only the claim made for it that it was favorable to the preservation of public order was urged in good faith. We are now asked to observe that all he said was that the policy in question—the proviso in question holding good—could not properly be described as socialistic. We accept the correction; but we think that so practiced a writer as General Walker might have guarded more effectually against misapprehension if he had tried. These were his exact words:

"The prevention of violence and crime is the proper function of the state, according to the lowest views that can be taken of it; and, if a certain amount of encouragement and assistance is extended to religious bodies genuinely in this interest, no invasion of individual initiative and enterprise can properly be complained of."

Our correspondent thinks that it would have been highly unscientific on his part to have dropped so much as a hint as to the completely unverified character of the claim supposed to be put forward on behalf of the policy referred to. It strikes us that the case is one in which Science might have sacrificed a little of its dignity for the sake of a public benefit. However that may be, we are glad to have it on record that General Walker does not commit himself in any manner, or to any extent, to the doctrine that church property ought to be exempt from taxation. It is more important and satisfactory to know this than to know that he does not regard the doctrine as a socialistic one; especially when we consider how little difference it makes, from General Walker's point of view, whether a doctrine is socialistic or not.—*Editor.*

EDITOR'S TABLE.

STATE EDUCATION.

WE publish elsewhere a letter calling in question the opinion expressed in these columns last month that education was properly a matter for the family rather than for the state —for private enterprise rather than for governmental control. The arguments used by our correspondent have, we need hardly say, long been familiar to us; and therefore their restatement does not affect our conclusions on the question at issue. It is, however, due to our correspondent, and perhaps also to our readers, to deal briefly with some of the points raised in his letter.

He says that the alternative to state education is the "*laissez-faire*, or go-as-

you-please system." We ask whether everything that is left to private enterprise can properly be said to be left to a "go-as-you-please system." If so, all we can say is, that the system in question, call it as you will, produces some very good and marvelous results. *Laissez-faire* has made the railway systems of this country and of England; it has made great steamship companies and telegraph companies and life-insurance companies; it has organized the most gigantic industrial and commercial enterprises, and provided in the most wonderful manner for the whole material life of the community. To say that a social function not controlled by the Government must necessarily fall into disorder (which, of course, is what the term "go-as-you-please" is meant to imply), is to go further than our correspondent probably meant to go, or than any sensible man would go; and yet the contrast he seeks to draw between governmental methods and the go-as-you-please system involves this as a general principle. But is there no go-as-you-please in governmental methods? Is our public-school system free from the intrusion of vicious political influences? Are not teachers in different states agitating at this very moment for some greater security in their positions than can be enjoyed under existing laws? And do not they feel that their usefulness is continually being impaired by their dependence on the favor of trustees who are themselves dependent on the political machine? We know of no go-as-you-please that is more destitute of all moral impulse or direction than the go-as-you-please of municipal politics. It is really go-as-the-boss-pleases, and the boss goes for the offices and the plunder by the most direct road! We attach the educational interests of the community to precisely the faultiest part of our whole political system, and then exult that we have rescued it from the *régime* of go-as-you-please! Well, when we say "we," we must be allowed to exclude ourselves, for *we* don't.

Our proposition is characterized by our correspondent as "revolutionary." We think the word too strong; call it radical if you like, seeing that it goes to the root of things; but we think it a mild form of revolution to propose that people should not look to the Government to educate them. We should like to see the people educating the Government; and the people could do this if they would only first educate themselves.

Our correspondent has the true democratic spirit, and does not want to see classes formed in this free country; nevertheless, he talks of "the poor" as people whose children ought to be educated at the expense of the "wealthy tax-payers." If this is not establishing classes with a vengeance we don't know what is. We hold that nothing would tend more to raise the spirit of the poor and enhance their sense of citizenship and of social equality than to feel that they did *not* depend on the rich for the education of their children, but that they provided for that all-important object by their own labor, and, if necessary, self-denial. If the rich are to contribute of their substance to the poor under legal compulsion, why should education in particular be the thing for which they are called to pay? Why not provide shoe-leather or blankets, and let the poor have the benefit that assuredly would come to many of them from having a direct interest in their children's education? But the whole idea of the rich being bound to contribute to the maintenance of the poor is a vicious one. If such an obligation, properly enforcible by law, exists, then —let us not hesitate to say it—there must be something rotten in our economics; and we can not too soon apply ourselves to finding out what that is, instead of dealing in weak and ineffectual palliatives.

But, we are told, the public-school system educates the people more rapidly than private education could possibly do—educates a greater number in

a given time. Does that settle the question? Does the quality of education, do the moral influences accompanying it, count for nothing? Whether would it be better to give five hundred an education destitute of moralizing and idealizing influences, or three hundred an education penetrated by those influences, trusting to the action of the smaller number to promote social order and harmony? We ask these questions not as advancing assumptions, but merely to show that all is not said when it is alleged that the state can educate more rapidly than private enterprise. If private enterprise and family effort can educate *better* than the state—better on the whole, taking both intellectual and moral development into account, and also the reaction on the elder generation—the higher value of the work may more than atone for its narrower range.

It is a singular thing that, in spite of his strong faith in state education, our correspondent does not seem to believe that any extension or continuance of it would have the effect of making the people at large so intelligent and self-helpful that, in the future, they would be willing and able to look after the business of education for themselves. He seems to look forward to the perpetuity of the system under which the "wealthy tax-payers" provide funds for the education of the children of the poor; at least he drops no hint that the system is ever to cease. Now, supposing we were to address "the poor" in these words: "Well, good people, we are educating your children for you gratis or nearly so, because we don't imagine you have either the ability or the inclination to educate them without our help. At the same time, please to understand that we don't expect, by any education we may give your children, to make them self-helping when they come to have children of their own. A few of them, of course, may rise, while others, more advantageously situated at present than they, and getting the same education, will fall; but the bulk of them will remain as you are to day, unable to educate their children without the benevolent help of the rich. But don't be afraid for your posterity; the rich will help, as usual. There are no classes in this country." How would all that fall on the ears of the poor? Would it be extraordinary if some one on their behalf were to reply: "If we or our children are not to be educated *out of* our poverty—a poverty so deep as to draw down upon us your insulting patronage—we see but little good in it. Better not to sharpen by knowledge the edge of our misery!"

Let us ask a question. As education spreads in this country, are social distinctions becoming less marked? Are inequalities of fortune becoming less striking, not to say portentous? Our correspondent dreads the spirit of socialism and anarchism, and thinks it may grow if the state does not push popular education vigorously. But the state has been pushing popular education as vigorously as it knew how; and, precisely when our educational status, so far as figures can show, is at its best, do socialism and anarchism, in forms unknown to an earlier generation, raise their misshapen and scowling heads. Might not this have something to do with the *quality* of the education imparted? Might it not have something to do with the withdrawal from the poor of one of the best of all moral influences, that which comes from a direct interest in the education of their own children? Our correspondent wants to have political economy taught in the schools so kindly provided by the rich for the poor. Whose political economy — Marx's or Mill's? Henry George's or President Walker's? It is precisely because they know that the rich not only provide, but in a large measure control, public education, that the poor have such an aversion to all the more orthodox forms of political economy. They want no official doctrines on *that* subject.

No, the more the matter is looked into, the less reason (we believe) there will be found to congratulate ourselves on the overthrow by the state of the old system under which parents planned and contrived and economized in order to get their children taught the rudiments of knowledge. Private education, it is true, has not been entirely destroyed, for well-to-do parents—those who so generously provide public schools for the children of the poor—often prefer private schools for their own children; but it has been destroyed precisely where it used to do most good, namely, among the poor. It may be "revolutionary," but we confess we should like to see the "*laissez-aller*," the "go-as-you-please," if it must be called so, of private enterprise—backed as no doubt it would be by the full force of the modern pulpit—applied to the business of education, without the least help or interference from the political machine, and without any legally enforced contributions from "wealthy tax-payers." Education would then rest on a natural basis, and would have a force and a tone that now it almost wholly lacks. Instead of tending to build up social distinctions, the change would have a directly opposite effect by cultivating among even the poorest a manly self-respect. The intellectual and moral effort which it would impose upon society at large would be in itself an educative influence of the first importance, and would probably go far to arrest a growing vice of the age—a tendency to frivolity. It is not by taking away objects of thought and care from the poor that we are to create a stable society; it is by giving them worthy objects of thought and care. Lastly, by leaving education to be provided for by the direct contributions of the beneficiaries, we should probably raise the general level of wages for the poorer classes, seeing that this is governed more or less in all countries by the general standard of living. At present the general standard of living among the poor does *not* include provision for education; but does any one who understands anything of economic laws imagine that wages have not adapted themselves to that condition? It appears, therefore, that what the rich give with one hand they take away with the other, and, as a reward for their generosity, are allowed to control in considerable measure the education of the poor. Who gains by that arrangement?

We are glad our correspondent has given us the opportunity of making these remarks. As he is evidently a man of much intelligence, we commend the whole matter anew to his consideration; and, in connection therewith, would urge him to read what Herbert Spencer has written on the subject in the fifteenth chapter of his "Study of Sociology."

THE NEXT MEETING OF THE AMERICAN ASSOCIATION.

New York, we understand, is this year to have the honor of entertaining the American Association for the Advancement of Science, the thirty-sixth annual meeting having been appointed to be held in this city, for the second Wednesday in August. There are many reasons why our people should give the Association a hospitable and hearty welcome, and spare neither effort nor money to make its visit pleasant and its meeting a success. While this is the largest city on the continent, it enjoys the unenviable distinction of being one of the very few that have never entertained the Association, although that organization is now nearly fifty years old. This is in strange contrast with the well-known liberality and intelligence of our citizens, who have been unstinted in their hospitality to numerous other bodies, with certainly no greater claims to attention; and the omission is made all the more conspicuous by the fact that several towns, not one tenth the size of New York, have already had the Association two or three times. There is,

moreover, no community on this side of the Atlantic which is under a larger indebtedness to Science than this one. By virtue of our position we enjoy, far more than any other city, the fruits of the immensely extended commerce of the country, and of the enormous development of its manufacturing and productive interests, all of which have been carried to their present high state of efficiency by the applications of Science. Our close relations and rapid intercourse with foreign nations, the constant interchange of objects of use, art, and thought, involving incessant improvement in all departments of human activity, have been fostered and perfected, either directly or indirectly, through the investigations and discoveries of the workingmen of this and kindred associations; and all the results thus achieved, whatever their form, pay tribute, in one way or another, to the prosperity of the metropolis. Then we have a right to count upon the social and educational advantages of the presence of the Association among us. By its very character it must elevate the aspirations and tastes of the people among whom it meets, in a way that, though the effect is diminished as the circle extends, is nevertheless very widely felt. Those charged with the care of our educational interests can not fail to be helped by its coming. Above all things, they need the spirit of free and independent inquiry encouraged by its meetings, and a little of which, applied to existing educational methods, could not fail to result in marked improvement. That we have something to learn in this respect, and that these visiting Associations may be able to give us material aid, was shown by the incident of the School Industrial Fair, held under the auspices of the "Industrial Educational Association of New York" in this city last year. Many schools outside of New York were represented by exhibits showing the skill of pupils in the useful and ornamental arts, and reflecting great credit on the management of those schools. Our city, with its boasted "system," was wholly unrepresented. But a direct result of the exhibition was to wake up the school authorities, and next time they are not likely to be found so far behind their country *confrères*.

It is to be regretted that the appointment of the meeting was so long delayed. Even a full year's notice is not always enough; indeed, in this respect, the example of the British Association, which fixes its place of meeting two years in advance, is to be commended. But while the time is short for the preparations necessary to make the reception one that shall be wholly worthy this great city, enthusiasm issuing in prompt and energetic action may do much to compensate for this; and it is clearly due to our self-respect, and the reputation we have for liberality abroad, that we set to work with a determination to make the meeting a notably successful one in the history of the Association.

LITERARY NOTICES.

OUTLINES OF CLASSIFICATION AND SPECIAL MORPHOLOGY OF PLANTS. By Dr. K. GOEBEL, Professor in the University of Rostock. A new edition of SACHS'S TEXT-BOOK OF BOTANY. Book II. Authorized English translation. By HENRY E. F. GARNSEY, M. A. Revised by ISAAC BAYLEY BALFOUR, M. A., M. D., F. R. S., Sherarden Professor of Botany in the University of Oxford. With 407 Woodcuts. New York: Macmillan & Co. 1887. Pp. 500. Price, $5.25.

AS STATED above, this work is a new edition of Part II of Professor Sachs's "Morphological and Physiological Botany." It was prepared at the desire of Professor Sachs because of the rapid growth of discovery in this field since the publication of his work in 1873. Although the researches of Professor Sachs were largely confined to the lower groups of the vegetable kingdom, especially to the vascular cryptogams, and were here first given to the world, in Part II of his text-book. Of its 850 pages 250 sufficed for the treatment of morphology and classification. Such, however, has been the

activity of investigators in this field in the last few years, that Professor Goebel has taken 500 pages for its present treatment. Of these 500 pages three fourths of the space is given to that section of the vegetable world popularly known as flowerless plants; for it is here, where so much was uncertain, that research has been most active.

Professor Goebel is himself an original investigator in botany, and the present volume contains not only the changes required by the recent literature of the science, but the results of his own research. Under the circumstances, it will be no matter of surprise that the provisional classification of the past has given place to considerable and important changes. Among these it may be mentioned in the first place, that the division of the vegetable kingdom into cryptogams and phanerogams is out of date. The discovery of the true relations between phanerogams (gymnosperms and angiosperms) and the vascular cryptogams has revealed that the gymnosperms, mosses, and vascular cryptogams form a natural group aptly described as *Archægonatæ*. "It would be thoroughly in accordance with our present knowledge to divide the forms of the vegetable kingdom into thallophytes, Archægonatæ, and angiosperms." For the sake of simplicity of statement, however, the gymnosperms and angiosperms still form one division called seed-plants (spermaphytes). The vegetable kingdom is divided into four groups: Thallophytes, briophytes (mosses), vascular cryptogams, and seed-plants. In classifying the lowest group, or thallophytes, it is now established that lichens do not form a special class distinct from algæ and fungi, but must be ranked with fungi. In consequence of the present transitional character of botanical terminology, Professor Goebel has found it difficult to explain the relations of the different groups to each other, and has been obliged to modify the terminology of previous editions. But he has given a very full "Explanation of Terms" at the end of the volume. A prominent feature of the book is an attempt to make use of a consistent terminology based upon homology; and Professor Goebel expresses the hope that the work of improvement will continue until "we shall no longer call the same object in one place a 'placenta,' in another a 'receptacle' or a 'columella,' or use the term 'frons' for the thallus of a Marchantia or a Pellia, or apply the term pro-embryo alike to the protonema of the mosses, the prothallium of ferns, and the suspensor of spermaphytes." This volume will be indispensable to teachers who care to give their pupils the latest product of scientific inquiry.

HISTORY OF THE PACIFIC STATES OF NORTH AMERICA. By HUBERT HOWE BANCROFT. Vol. XXVII. BRITISH COLUMBIA. San Francisco: The History Company. Pp. 792. Price, $5.

THERE is little in this book to remind one of the times when "54° 40′ or fight" was the political cry of the day, and of the great excitement which our country suffered over the Oregon question. Yet the subject of the dispute is the precise territory that was involved in that controversy. That the memory of that dispute should have so lapsed in forty years that it should be only incidentally referred to, if at all, in this volume of nearly eight hundred pages, is a silent comment on the changes that may be wrought in a generation, and a sign of the growing civilization of the age. The period covered by this history is from 1792 to 1887. It is divided by the author into six divisions: First, the discoveries, claims, disputations, and diplomacies relative to the ownership and division of the domain, commonly referred to as Nootka affairs. The second epoch began with the coming of the fur-traders by land, and continued until 1849, when colonization and colonial government began on Vancouver Island. The third term, during which the Hudson Bay Company was still everywhere dominant, lasted till 1858, when the gold discovery overturned the existing order of things, and raised the mainland into a colony. The fourth period, during which there were two colonies and two governors, concluded with the union of the island and mainland under one colonial government in 1866. The affairs of the confederated colony constitute the fifth era, terminating in confederation with Canada in 1871. The present may be regarded as the sixth period. At this time,

or in 1886, we are informed that British Columbia, on account of the lack of money in circulation, is not adapted to any large immigration of poor families; but for men possessing even a small capital, there are few more profitable investments than a cereal farm or cattle-rancho within its borders. As an agricultural region the mainland is divided into sections by the Coast Range. The interior has a climate of extremes, and the coast a mild and equable temperature, while the southern portion, with its wide, trough-like valleys, requires irrigation during the summer months. Though it contains large tracts of good arable land, the entire province is better adapted for stock-raising than for the production of crops. Vancouver Island contains not more than 300,000 acres of farming-land, of which less than 15,000 acres were under cultivation in 1886. In the Queen Charlotte Islands there are some 15,000 acres of flat and unwooded land, but of this only a few hundred acres are suitable for agriculture. Public lands are vested in the provincial government, and the policy is followed of reserving them, in the main, for actual settlers. The exports in 1884 amounted to $3,099,814 and the imports to $4,142,286. The exports consisted mainly of coal and gold, fish and fish-oils, peltries, hides, and lumber. The population is described by the author as, if not among the richest, among the most contented, hopeful, and thrifty communities of the Pacific coast, and the colony as entitled to claim the distinction of being one of the most progressive regions of British North America.

SHOPPELL'S MODERN HOUSES: AN ILLUSTRATED ARCHITECTURAL QUARTERLY. January, 1887. New York: Co-operative Building Plan Association, 191 Broadway. Pp. 72, with Colored Plates. Price, $1, $4 a year.

THE design of this publication is to furnish, with views and plans, designs for houses, etc., in number, from which intending builders may select such as suit them or nearly suit them. Working plans, specifications, etc., will be furnished on application, with plans of such alterations as may be desired, at fixed rates. Estimates of cost are based upon actual cost of structures, such as will be secured by buying the materials and having the labor performed by days' work. The Association represents that within six years eight thousand houses have been built from its plans. The present number of "Modern Houses" contains forty-nine designs for houses, with plans, descriptions, and costs, from $1,000 to $12,000; designs for a railroad-station, and for stables and carriage-houses; articles on "Axioms and Rules of Color"; "Plumbing and Draining"; "Planting a Large Plot"; "Sea-side Cottage Decoration"; and an installment of Viollet-le-Duc's "Habitations of Man in All Ages," which is in course of regular publication.

THE OPEN COURT. A Fortnightly Journal, devoted to the Work of establishing Ethics and Religion upon a Scientific Basis. Edited by B. F. UNDERWOOD and SARA A. UNDERWOOD. Chicago, Ill. $3 per year, single copies fifteen cents.

THE aim of this journal, established through the liberality of Mr. Edward C. Hegeler, is announced to be "to continue the work of 'The Index'—that is, to establish religion on the basis of science; and, in connection therewith, it will present the Monistic philosophy." The new journal starts out under good auspices; it is published in convenient form, its typography is very attractive, and, under the charge of the well-known editor of "The Index," we may reasonably expect a successful career.

The four numbers before us contain articles by William J. Pottor, upon "Society and the Individual"; Professor Thomas Davidson, upon "The Need for Free-Thought Education"; Edmund Montgomery, upon "Monism in Modern Philosophy and the Agnostic Attitude of the Mind"; by Moncure D. Conway, upon "Unitarianism and its Grandchildren" and "Jephthah's Daughter at Honolulu"; and by Anne Olcott Crommelin, upon "Flowers and Poets." There are also an editorial department, correspondence, discussions, and book-notices.

With the aims of "The Open Court" we are in full sympathy. There can be no more worthy nor more important object than that of establishing a scientific basis for ethics and religion. The times are ripe for labor in that direction, and able, well-directed efforts thereto ought to be welcomed and encouraged in every way. We

trust "The Open Court" will become a potent influence favoring the reduction to a scientific platform of the principles and precepts of these great departments of human interest.

We do not understand that the presentation of the "Monistic philosophy" is intended to make the successor of "The Index" an *organ* of any theory of knowledge or being; for, while philosophy is not to be disparaged, it is far better to stand firmly upon science, and thence reach outward and onward to philosophy with much caution. If the prime object of the journal is the scientific study of morals and religion, it is not likely to become conspicuously a vehicle for the expression of speculation, but will, as "The Index" used to do, make the practical work of improving men's lives and promoting the organic growth of society its chief end, quite irrespective of philosophical or metaphysical doctrine.

THE CHEMISTRY OF THE SUN. By J. NORMAN LOCKYER, F. R. S. Illustrated. London: Macmillan & Co. Pp. 457. Price, $4.50.

THE general problem of the chemical constitution of the sun's atmosphere, to which the author has given a large share of his attention for many years, is among the newest and freshest, as well as one of the grandest and most fascinating, questions which science has yet attempted to answer. Although astonishing progress has already been made in this field, considering the difficulties encountered, yet the work is so vast that the time of many observers must be devoted to it before it can be said to be more than begun. The first step in the direction of spectrum analysis was taken by Kepler, who, one hundred and fifty years before Newton, observed the decomposition of white light by the prism. Nothing further was done till Newton took up the subject, and by reasoning and experiment greatly enlarged our knowledge of it. Another period of a century and a half elapsed, and then Wollaston discovered that the spectrum of sunlight is divided into several portions by dark lines. In 1814 and the following years the first great advances in spectrum examination were made. Fraunhofer constructed a map of the solar spectrum, on which he marked no less than five hundred and seventy-six dark lines, and these have ever since been known as Fraunhofer lines. His attempts to account for the lines satisfied him that they were not due to any terrestrial cause, but that "they have their origin in the nature of the light of the sun." He introduced the use of the telescope for observing the beam of light after its passage through the prism. He also introduced the method of observing stellar spectra which is still employed, and he investigated the spectra of artificial light-sources. Sir David Brewster discovered that dark lines were produced in the spectrum when nitrous-acid gas was interposed between the prism and the source of light. Many of these lines seemed to him to be identical in position with some of the Fraunhofer lines in the solar spectrum, and he accordingly felt himself justified in announcing the discovery of nitrous-acid gas in the atmosphere of the sun. This was the first chemical touch in solar inquiry. He also stated his belief that all the Fraunhofer lines were due to some absorption at the sun. Foucault then discovered that the bright lines from a colored light had the same places as the dark absorption bands from the same source. In 1852 Professor Stokes first proposed an explanation of this phenomenon, and the same idea was published by Ångström in the following year. The famous discoveries of Kirchhoff and Bunsen began to appear in 1859. Among the earliest of these was that the absorber must be cooler than the radiator. Stokes had suggested that the presence of many terrestrial elements might be detected in the sun's atmosphere by a comparison of the spectra of these elements with the Fraunhofer lines, in the way that sodium had already been detected. Kirchhoff attacked this problem vigorously and obtained abundant results, finding nine terrestrial metals present in the solar atmosphere. Ångström and his collaborator, Thalèn, were occupied with similar inquiries.

About this time Mr. Lockyer's work on solar phenomena began. He applied to the examination of sun-spots and faculæ the device of throwing an image of the sun, or of any desired part of the sun, on the slit

of the spectroscope. Up to 1866 it had been possible to examine the solar prominences only during eclipses. In that year Mr. Lockyer devised a method of observation which can be used at other times, making for the observer what have been called "artificial eclipses." It was the illumination of our air that interfered with such observations, and he abolished this interference by using several prisms in the spectroscope, which, by successive dispersions, so greatly enfeebled the continuous spectrum of the light diffused in the air, that the bright lines due to the prominences could be readily seen. Current investigations were being made on the basis of Kirchhoff's hypotheses, that the absorption which produced the Fraunhofer lines took place at some distance above the photosphere, the spots being solar clouds, and that the chemical elements present in the solar atmosphere were identical with some of those existing on the earth, and their spectra were identical. The observations of Mr. Lockyer and his collaborator, Dr. Frankland, soon led them to propose modifications in Kirchhoff's theory, for they showed that the dark lines increased both in width and number as the photosphere was approached. Moreover, the lines in the spectra of the various terrestrial elements were found not to coincide so perfectly with the Fraunhofer lines as had been believed. Certain lines were found in the spectra of two or more substances, and the same substance was found to have more than one spectrum. Difficulties multiplied. The sun had been regarded as a type of what our earth once was, but spectrum analysis apparently showed it to have a chemical constitution widely different from that of the earth's crust. Only one terrestrial substance classed as non-metallic (hydrogen) had been found on the sun, while no trace of elements so common on the earth as oxygen, silicon, and chlorine, could be discovered. It had been noted by Ångström that spectral lines vary their intensities with the temperature. This is the starting-point from which Mr. Lockyer develops his theory of the chemical constitution of the solar atmosphere. When a metallic compound vapor is dissociated by the electric spark, the character of its spectrum changes from channeled and banded to lined. The effect of increasing degrees of heat within the limits known on the earth is to reduce compound bodies to simple ones. Now, on the sun occur temperatures immeasurably greater than we are able to produce on the earth, and it occurred to Mr. Lockyer to ask if iron, for example, were subjected to the heat of the sun, whether it would exhibit the spectrum of iron, or the spectra of some simpler substances—the constituents of iron. Many facts relating to terrestrial, solar, and stellar spectra unite to convince him that in the reversing layer of the sun a high degree of celestial dissociation is at work, which prevents the coming together of the atoms which at all temperatures yet attained on earth compose the metals, metalloids, and compounds. He has applied many and various tests to this theory, but the results of all serve only to confirm his belief. The theory also seems to him to conform satisfactorily to the observed physical phenomena of the sun. Mr. Lockyer has stated his views, and detailed the investigations which led up to them, in a way that will command the attention and respect of scientists, even where he does not produce conviction. Moreover, his work and that of his predecessors has been described in so clear and interesting a style, that the general reader will be able to go through the book with pleasure and profit.

MINERAL PHYSIOLOGY AND PHYSIOGRAPHY. A Second Series of Chemical and Geological Essays, with a General Introduction. By THOMAS STERRY HUNT, M. A., LL. D. (Cantab.). Boston: Samuel E. Cassino. Pp. 710.

THE essays of which this volume is made up have been written in accordance with a predetermined plan that is now accomplished. The first and second are intended to serve as a general introduction, and to show the relations of the natural sciences to each other, and to that complex study known as geology.

The first essay is entitled "Nature in Thought and Language," and gives historical and philosophical reasons for the use of the term physiology in relation to the mineral kingdom. The second embodies a simple scheme for the classification of the natural sciences, by which the sciences of

inorganic and those of organic nature are divided into a descriptive and a philosophical group. In writing the six succeeding essays it was the author's design to bring together in a concise form the facts and the reasonings from which are deduced what he regards as the *principia* of geogeny, geognosy, and mineralogy. The chemistry of the atmosphere, and the relations of the earth's aërial envelope both to outer space and to the gases condensed, and the waters precipitated on the surface of the globe, are set forth in the third and fourth essays, as a preliminary to the study of rock-masses. In the next three essays the genesis and the geognostic relations of the various crystalline rocks are considered; and finally the decay of these, which has determined their present surface-outlines, and has given rise to the materials of the uncrystalline sedimentary strata. In the fifth essay, Professor Hunt attempts to show the defects of the several other proposed explanations of the origin of the crystalline rocks, and sets forth his crenitic hypothesis, according to which they have been derived—for the most part indirectly and by aqueous solution—from a single primary plutonic mass. These and other related points are more fully discussed in the sixth essay.

A system of classification for the mineral species composing the earth's crust, which should consider their physical characters in connection with their chemical composition, and the mode of formation of mineral species, has seemed to the author for many years to be a desideratum. What he believes to be a natural classification of the native silicates is included in this volume, and is followed by an outline of the system as applied to all other native minerals. Regarding the silicates as a natural order, Professor Hunt divides them into three sub-orders: those without alumina, which he calls *protosilicates;* those with alumina and containing combined protoxides, *protopersilicates;* and those with alumina, but no protoxides, *persilicates.* These sub-orders are divided each into five tribes, according to distinctions of structure, hardness, and density. Each tribe is made up directly of species. The silicates are included in the same class with the oxidates, titanates, niobates, tantalates, tungstates, molybdates, chromates, vanadates, antimonates, arsenates, phosphates, nitrates, sulphates, borates, carbonates, and oxalates. This class is numbered II; Class I comprises the metallates; Class III, the haloidates; and Class IV, the pyricaustates, or combustible species. The author has in preparation a treatise on mineralogy which will be a complete presentation of this system.

The next essay deals with the geological history of pre-Cambrian rocks, both in North America and in Europe, and is mainly a condensation from the account given in the author's volume on "Azoic Rocks." Intimately connected with this subject is the history of serpentines, which is sketched in the following essay. The various opinions as to the geognostical relations of serpentines which have been held by different writers are shown, and the author's reasons for maintaining their aqueous origin are given. In the concluding essay, the question of the Taconic rocks is discussed at some length. The eleven essays which are collected in this volume are papers which have been presented to American and British learned societies, and have been published in their transactions and in scientific journals. Changes have been made occasionally in revision, but all additions of importance are inclosed in brackets.

ANNUAL REPORT OF THE CHIEF SIGNAL-OFFICER OF THE ARMY FOR THE YEAR 1885. Washington: Government Printing-Office. Two vols. Pp. 609, 440.

THE course of instruction pursued at Fort Meyer has been enlarged and otherwise improved, and now provides for theoretical and practical instruction in the duties required of the Signal Corps in time of war. Lectures by professors of meteorology have been provided for; and a course of instruction in military surveying, field-sketching, and topographical drawing has been added. A text-book of meteorology has been prepared by Professor William Ferrell, and forms the second part of the present report. Professor Cleveland Abbe has in preparation a treatise on the theory of instruments used in meteorology. Translations of papers on temperatures and storms by Ragone and Wild are appended; and translations have been made of impor-

tant treatises on meteorology; and other translations, giving the most recent and trustworthy results, are in course of execution. The special indications for particular localities have been largely increased. Of the "general indications," from 82·6 to 87·3 per cent monthly were verified during the year; of the Pacific coast indications, from 76·7 to 92·3 per cent; of the cautionary off-shore signals, 93·6 per cent for direction, and 85·3 per cent for velocity; of the cold-wave signals, 86·2 per cent. Four hundred and eighty-nine stations were in operation on the 30th of June, 1885.

THE FALL OF MAXIMILIAN'S EMPIRE AS SEEN FROM A UNITED STATES GUNBOAT. By SEATON SCHROEDER, Lieutenant U. S. N. New York: G. P. Putnam's Sons. Pp. 130. Price, $1.

"A LETTER-BOOK and a log-book," says the author, "are the foundation upon which the fabric of this narrative rests." Lieutenant Schroeder was attached to the United States Steamer Tacony, Commander Roe, which was dispatched to Mexican waters in 1867, "to protect American interests" in those regions while the people were ridding themselves of the French and their Austrian mock-emperor. He was, therefore, more or less a personal observer of the events that occurred from that time till the intruders were finally expelled, and Maximilian was executed; and of all those transactions in which foreign agents could participate. Besides what he saw himself and heard from his intercourse with the officers of the fleets of other nations stationed in the same regions, "a scrutiny of various executive documents, departmental files, and volumes of diplomatic correspondence, has elicited from those musty sources certain interesting matters not presented in any history connected with the closing scenes of Prince Maximilian's short reign in Mexico." The result of the whole is a modest, straightforward narrative which is a contribution to history.

AGRICULTURE IN SOME OF ITS RELATIONS WITH CHEMISTRY. By F. H. STORER. New York: Charles Scribner's Sons. Two vols. Pp. 529, 509.

THIS book, the author says, has been written in the interest of persons fond of rural affairs, and of students of agriculture. It makes no special appeal to chemists or to students of chemistry. It is based upon lectures, suggestive rather than encyclopedic, which have been delivered annually by the author at the Bussey Institution during the past sixteen years (1871–1887). These lectures, which have been many times altered and revised, were addressed to small classes of students of two distinct types—viz., young farmers, and sons of farmers, familiar with the manual practice of agricultural operations, who were desirous of studying some of the sciences which bear most immediately upon the art of farming; and city-bred men, often graduates of the academic department of the university, who intended to establish themselves upon farms, or to occupy country-seats, or to become landscape-gardeners. The lectures are upon a considerable range of subjects, which may, perhaps, be only partly covered by such headings as the relations of soil, air, water, and the plant; tillage; manures (including the chemical action of the soil, the special manures in their variety, animal and vegetable refuse, green manuring, vegetable mold, farm-yard manure, composts, night-soil, etc.); rotation of crops; action of fire on soils; irrigation; sewage; the disposing of farms; various crops; and pastures. To such inspection as we have been able to give them, the practical value of the lectures appears high as compared with most other works of the class.

A QUARTERLY journal is to be started at an early date, to be entitled the "American Journal of Psychology," and to be under the editorial control of G. Stanley Hall, Ph. D., of Johns Hopkins University. It will attempt to gather up and present, in a compact, accessible form, the results of scientific psychological research which are of value and are now widely scattered, and even have sometimes to be looked for in other departments of science. It will contain original contributions of a scientific character, recording experiments and studies in all branches of the subject; papers of importance from other journals; and digests and reviews, in which attempts will be made to give a conspectus of the more important psychological literature of the three months preceding publication. Each

number will contain from sixty to one hundred pages, and the subscription price will be $3 a year.

TALKS WITH SOCRATES ABOUT LIFE. Translations from the Gorgias and the Republic of Plato. New York: Charles Scribner's Sons. Pp. 173. Price, $1.

THE character of the dialogues from which these selections are taken is too well known to require any special notice here. The text is preceded by an introductory analysis of the purpose of the "Talks" and accounts of the interlocutors, and is followed by annotations. The conversation is described as relating to the perpetual controversy between the material and the ideal, and concerning the real original existence of the moral law.

UNITED STATES COMMISSION OF FISH AND FISHERIES. Report of the Commissioner for 1884. Washington: Government Printing-Office. Pp. 1204.

BESIDES its usual routine work, the commission directed a number of special undertakings, all of which are fully described in the report and the accompanying papers. Among them were the prosecution of the work on the pier, buildings, etc., at Wood's Holl; the construction of oyster-ponds at Wood's Holl and St. Jerome, and the investigation of the oyster-beds of Chesapeake Bay; the trip of the Albatross to the Caribbean Sea; the investigation of the Florida shad-fisheries, and the examination of the oyster-beds in Long Island Sound; the investigation of the fish-epidemic in Wisconsin lakes; the collection of specimens of cetaceans; the occupation of stations at Fort Washington on the Potomac, and at Weldon, North Carolina; efforts to hatch the codfish at Wood's Holl; the planting of lobsters in Chesapeake Bay; and the importation of the blue carp and of the European trout. The Appendix, which forms most of the volume, and is devoted to special papers and reports in full, contains the reports of steamers (the Albatross and Fish-Hawk) and stations; fifteen papers of a general or statistical character on the fisheries of this country and Northern Europe; five papers on fish-culture, including a long one, by Carl Nicklas, on pond-culture; a series of statements from persons immediately engaged on some results of carp-culture in the United States; and papers on oyster-culture; five papers detailing scientific investigation; a statement by G. Brown Goode, of the status of the commission in 1884, etc.

RECENT ADVANCES IN METEOROLOGY. By WILLIAM FERREL. Washington: Government Printing-Office. Pp. 440.

THIS hand-book constitutes the second volume of the report of the Signal Service for 1885. It aims to present the principles of meteorological science and their applications as they have been developed up to this time, for the use of students, and especially for the purposes of a text-book to be used in the Signal-Service school of instruction at Fort Meyer, Virginia. The effort has been made to select, from the material on hand, that which bears most usefully upon practical meteorology. The mass of matter was, however, found to be too large to be compressed into a volume of the size this was intended to be, and selection was necessary. Plain clews are, nevertheless, given to all facts and observations not directly discussed in the book, by references to the works and papers in which they are treated of. Many researches and problems are subjected to mathematical treatment; and an important feature of the work is found in the formulæ and tables which are so frequently needed in meteorological computations and discussions of observations, with examples for their application.

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Stowell, T. B., Ph. D. The Facial Nerve of the Domestic Cat. Pp. 19.

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POPULAR MISCELLANY.

A Fraudulent Benefaction.—The tricks of fraudulent schemers are endless, and are marked by the greatest craft, so that even the most wary are sometimes taken in by them. There came to us some months ago what purported to be the honest proceedings of a national society—"The Fruit and Vegetable Growers' Association of the United States." Among the "Transactions" was the approval of an offer, by the inventor, of freedom to make and use a fruit-evaporator, said to be superior to any ever before devised. Trusting to the honest appearance of the item, we noticed it as a public good, and the notice appeared in our last number. We are now informed, by Mr. Oscar C. Gibbs, editor of the "Farmers' Review," Chicago, in a note, for which we thank him, that the whole affair, including the society and the evaporator, is fraudulent. He writes:

D. Appleton & Co.:

GENTLEMEN: In your "Monthly" for April, on page 862, I notice an article entitled "A Fruit-Evaporator for the Public," purporting to present the proceedings of a meeting held at Columbus, Ohio (date not given), at which was offered to the "Fruit and Vegetable

Growers' Association" the plans of a fruit-evaporator, on condition that they should be published and furnished free to all applicants. This is simply a fraudulent scheme to secure free advertising, and of which "The Popular Science Monthly" has fallen a victim, unless the matter referred to in its columns was paid matter.* The scheme was tried on the agricultural press of the country last year, but with only partial success, as the fraud was soon detected and exposed. They now seem to have *tackled* the periodicals. I inclose a page from the "Farmers' Review" of July 28, 1886, which fully exposes the whole fraud. For any further information which you may desire, I refer you to the "Country Gentleman," "Rural New-Yorker," "Ohio Farmer," or any other reputable agricultural journal. Trusting that the next issue will contain such reference to this pretended association as shall counteract any advantage the parties might otherwise derive from the publication in the April issue, and will also put other periodicals on their guard,

I remain, very truly, yours,
O. C. Gibbs,
Editor "Farmers' Review."

Chicago, *March* 29, 1887.

It appears, from papers which Mr. Gibbs sends with his letter, that the object of the recommendation is to induce parties to write to the address given for the plans and drawings promised, when they are informed that another and still better evaporator has been put upon the market, which will be furnished them at a price less than the cost of making the "Arnold Evaporator." The pretended society consists of persons interested in the sale of the new evaporator; and the names of persons of known repute, which are enrolled in its list of members, appear to have been borrowed without the owners' consent. So, if any of our friends have intended to inquire about the "Arnold Evaporator" on the strength of our notice, we only have to say to them, "Don't." To those who may already have been misled by our item we offer our apologies.

The New York Skin and Cancer Hospital.—The New York Skin and Cancer Hospital was incorporated in November, 1882, and now has a city hospital building in East Thirty-fourth Street, at which more than four thousand cases have been treated by a staff of physicians of recognized competence, and a country branch of cottage pavilions at Fordham Heights, near High Bridge; the two properties being valued at about $80,000. The pavilions of the country branch are projected in recognition of the fact which has been abundantly verified in army practice, that such structures, light, airy, and admitting only a small number of patients at a time, are free from the objections which attach to the solid buildings of city hospitals with their crowds of patients occupying the same quarters year after year. They are much more easily and for a longer time kept free from the infectious qualities likely to attach to a permanent hospital, and the patient is relatively secure from the peril from poisonous influences which he is sure to incur in a city hospital. Being slight and cheap, they can be removed if they finally become infected, and their places supplied by new, clean, and entirely wholesome cottages. The estate at Fordham comprises sixteen acres of land in an elevated situation that commands fine views of the Hudson River and Long Island Sound. It will be occupied with cottages as they are needed, and the means are supplied for building them. Two have been built, and are in use, and four others are under way. The experiences of the past year, we learn from the recently published fourth annual report, have already indicated the wisdom of the new undertaking. "The favorable effects of fresh air, sunshine, quiet, and isolation upon the cancer-patients is shown in the prolongation of life, and in the comfort and helpful care it is possible to administer." Upon the record of what they have accomplished, the managers of the institution invite gifts for building other cottages, to be named by the giver, costing from $2,000 to $5,000 each; and endowments for beds, of $3,000 during the life of the donor, and $5,000 in perpetuity. The total cost of hospital accommodations for one hundred patients on this plan of building is estimated at $50,000, which, with $50,000 paid for the property, will make the price $1,000 a bed—a very small sum, compared with the cost in some other hospitals. The managers are aided in the care of patients by the Ladies' Auxiliary Board, by whose exer-

* Nothing of this kind has ever appeared in "The Popular Science Monthly" outside of the regular and avowed advertising pages, under any guise.—*Editor.*

tions a sufficient fund has so far been kept in hand to provide for the treatment of every patient who has made application; so that none have been turned away on account of inability to pay the cost of treatment. While it is not intended to make the institution a charity, it is desired to keep this feature up. A prize fund has been started to encourage the research for new and effective remedies and methods of treatment for cancer.

The American Society of Naturalists.—The meeting of the Society of Naturalists, which is composed of persons who regularly devote a considerable portion of their time to the advancement of natural history, was held in Philadelphia in the latter part of December, 1886. A prominent place is given in the proceedings of the society to the discussion of questions relative to methods of investigation and of instruction. At the present meeting the discussion on methods in teaching was led by Professors H. S. Williams and Davis, of Harvard College, on geology and geological investigation; Farlow, on botany; H. N. Martin, on collegiate teaching of biology; and Whitman, on the proper position of biological investigation in the university. It is contemplated to discuss the subject of science in the schools at next year's meeting.

Why English Trade is declining.—The latest English "Blue-Book" exposes the fact that English trade is falling behind in most countries, while German commercial interests are gaining the ascendant. The reasons for the change are somewhat complicated, but the principal ones may be summed up in the assertion that English merchants have lapsed into a kind of indifference about pleasing and accommodating their customers, while the Germans are taking great pains to ascertain and meet their wants. The reasons assigned for the superior vigor of German trade in Italy are a "higher standard of technical education, greater activity in the employment of commercial travelers speaking Italian, greater attention paid to the wants of the Italian market, and greater facilities for delivery and for payment." In Bulgaria, "some Jew from Vienna comes every week offering something wanted." The remark applies to several countries. "Ask an English manufacturer to alter the shape of an article to meet the requirements of foreign markets, . . . he generally refuses. The German manufacturer, on the other hand, has no prejudices; if he find that an article of a certain shape commands a ready sale in any particular country, he makes it, however foreign it may be to his own tastes and wants." So it is in Greece, Roumania, Servia, Turkey, Spain, and South America. The lesson is drawn from these facts by the "Spectator" that the English manufacturer must display more intelligence, more adaptiveness, more energy, more sympathy, if he is to hold his own against the increasing rivalry of the highly educated, active, and expanding German. His commercial education must be improved. Boys must be taught the modern languages, and be given a speaking as well as a grammatical acquaintance with the tongues of the peoples with whom they are to stand in commercial relations. But these and other branches of commercial importance still hold only a subordinate place in English secondary schools, while men of commerce and manufacture are trained almost entirely in subjects rather suitable for the professions.

Sewerage and Typhoid Fever.—The Baltimore "American" some time ago questioned the value of a system of sewerage in promoting the health of a city, and cited, in justification of its doubt, the case of Baltimore, a healthy city without a system, as opposed to Brooklyn and Boston, where the systems of sewerage are extensive, and yet diphtheria and scarlet fever and other like diseases are more prevalent than in Baltimore. The London "Sanitary World" answers these doubts by citations from the report of Mr. Erwin F. Smith to the Michigan Sanitary Convention on "The Influence of Sewerage and Water-Supply on the Death-Rate in Cities." This paper shows, almost decisively, that the introduction of sewerage and water-supply jointly has had a marked influence in reducing the mortality from typhoid fever, at least. The difficult point is to ascertain the influence of the sewerage alone. The introduction of a pure water-supply is unquestionably an important ele-

ment in producing this result. But whether the chance of air-pollution is greater from sewers or from cesspools is not so easy to determine. There are a few records, however, which will help to clear this point. In Berlin, the distribution of cases of fever has been found to be one to each 9·3 unsewered, one to each 49·3 sewered houses. In Dantzic the mortality from typhoid fever dropped to less than one fourth the old rate after the introduction of the sewers in 1872, and has been still lower during the last five years. In Cincinnati the water-supply is abundant, but the sewerage is imperfect, and the death-rate from typhoid is increasing. The city of Mexico enjoys a water-supply of forty-four gallons a day to each person, but there are no sewers, and the fever mortality is very high.

Various Kinds of Rivers.—M. Woeikoff, the Russian meteorologist, considering rivers from a climatological point of view and with regard to their sources of supply, makes several types or classes of them. The first are those which derive their waters from the melting of snows in plains or regions of not more than three thousand feet elevation; such rivers exist only in the extreme north. Next are rivers fed by the melting of snows in the mountains. Instances are the Amou and Syr Darias, the Tarim, and the upper Indus. In their lower course these rivers traverse regions where it seldom rains, or rains only in winter. High waters occur in them at fixed periods, and the maximum height depends on the quantity of snow on the mountains. They are utilized in the plains of their lower course, where cultivation would not otherwise be possible, in vast systems of irrigation. A third class of rivers depend on rains, usually tropical and monsoon rains, and reach their maximum in the hot season. They are best represented by the Congo and the Orinoco, in whose valleys snow never falls. They are low in winter, or the dry season, and reach their maximum stage in summer, when immense quantities of rain fall into them. Some of the tropical rivers, like the Amazon, are partly fed by melting snows, but in very small quantity; for the snow exists only on mountain-tops above twelve thousand feet in height. To this third class belong also the Nile, the Ganges, and Brahmapootra, and the great rivers of China. That the rivers of China, Mantchooria, and the Amoor region possess the common feature with tropical rivers of having their freshets in summer is a testimony to the prevalence of the monsoons in their regions of supply. To a class that receive most of their waters from rains, but are swollen periodically by the melting of the snows, belong most of the rivers of Western and Northern Siberia, European Russia, Scandinavia, Eastern Germany, and the Northeastern United States. The southern hemisphere has no such rivers. A fifth class of rivers depend on rain-water, are of constant flow, and are highest in the cold season, without being subject to sudden freshets. They are found in the eastern part of the United States, in New Zealand, and in South America beyond latitude 40°. Other rivers receiving their waters from rain, and being highest in the cold season, are marked by great differences between high and low water. They predominate in Southern Europe, and are exemplified by the Po and Tiber, and by some rivers in the United States. Other types may be constituted of rivers which become dried up or lost in their course, and of those which exist as streams for only a part of the year. They are found in desert regions.

Improvement of our Climate.—Mr. John C. Goodridge, Jr., has suggested a project for modifying the climate of the Atlantic coast by closing the Strait of Belle Isle, and advances the theory that this scheme is feasible as a problem in physical geography capable of an engineering solution. He argues that it is shown by charts that the great body of the "cold wall" comes to us through that strait. Newfoundland deflects the remainder of the Arctic current to the southeast. Here, pressing against the Gulf Stream, it veers southward in the form of a loop, and finally, running under it, goes on toward the equator. That part of the Gulf Stream that passes our shores has a course directly north and a little west, is deflected slightly toward the east by the coasts of South and of North Carolina, and thence turns more to the north again, when it is deflected by the cold current returning from the pole. When this

cold current is of least strength, as in August and September, the Gulf Stream comes within ten miles of Barnegat; at other times it is distant one hundred and twenty miles, changing with the amount of the cold current and of the wind. If we had not the cold wall between our shores and the Gulf Stream, it is fair to presume that we should have a less stormy coast, as the juxtaposition of these two currents with their difference in temperature must from that circumstance tend to an unstable condition of atmospheric equilibrium. Our cold northwest winds would then sweep to the north of us, and become westerly and southwesterly winds.

Production of Coke in the United States.—It is shown by the report of Mr. Joseph D. Weeks, of Pittsburg, to the United States Geological Survey, covering the period from 1880 to 1885, inclusive, that Pennsylvania stands first in the rank of coke-producing States, Alabama second, West Virginia third, and Tennessee fourth. The largest coke-producing locality in the country is the Connellsville region of Pennsylvania, in which were made 3,096,012 of the 5,106,696 tons, or 60·6 per cent of the coke produced in the United States in 1885. The second largest producing district is what is called the Irwin-Latrobe district, which lies along the Pennsylvania Railroad, from Larimer to Blairsville, and is, in part, the northerly extension of the Connellsville coking-field. The number of establishments has slightly decreased, but the number of ovens was increased from 1884 to 1885 by 2·8 per cent, and was in the latter year 20,116. While the production of 1885 increased over that of 1884, it was not as great as in 1883. There has been no increase in the value per ton of coke for three years.

How Harbor-Channels may be kept clear.—Professor Lewis M. Haupt addressed the Section of Mechanical Science and Engineering of the American Association on "River and Harbor Improvements, with Special Reference to the New York Entrance." He maintained that large and weighty structures intended to regulate currents, which rest or depend upon sandy or alluvial bottoms, violate the fundamental requirements that they shall not oppose the ingress of the tide or injuriously modify the currents. Dikes and jetties also are below the plane of action of waves of translation; while dependent upon their mass they are not entirely coherent; and they are wasteful, and result in serious modifications in the regimen of rivers and harbors. He suggested as a preferable system, one consisting of deflectors intended to be attached to buoys or floats, anchored to heavy moorings, and guyed in place on the ebb side by wire cables or chains. This system is composed of units or parts readily assembled, which occupy little space, yet control the currents, and deflect them upon the obstruction to be removed. By it the prism of water passing through a given section can be increased indefinitely, while the aperture of discharge may be diminished, thus producing any required velocity. Stress was laid upon the importance of applying a method which should be limited to the removal of so much of the crest of the bar as would secure the requisite channel, and no more.

The Amazons Valley.—Mr. James W. Wells, in an address before the Royal Geographical Society, on "The Physical Geography of Brazil," divides the rivers of that country into three great systems: the basin of the Amazons, including also the Tocantins and Araguaya; the basin of the Plate River, and the many distinct and separate rivers draining into the Atlantic. The Amazons basin is divided into the bottle-shaped, low-lying forest of the upper valley, 1,300 miles long by 800 miles broad, and its circumscribing elevated table-lands, which, near Obidos and Santarem, approach close to the banks of the main river, and constitute the neck of the bottle-shaped area. Throughout the length of this river, east and west of Obidos, the adjoining land is so low and flat that we have in many cases rather a series of more or less parallel streams than one great, clearly defined stream. It is possible to go in a canoe up the whole of the valley in these lateral channels, and also to pass through the deep forest by natural canals, from one tributary to another, without once entering the main river. It is a singular feature of the Amazons Valley, considering

the mass of the water and its equatorial situation, that it is so healthy as it really is. Some of the tributaries of the Amazon are very insalubrious, and life anywhere in them, in any condition, is made miserable by insect pests; yet Mr. Wells has never met any one, who has had an experience of life on the Amazons, who has not become passionately fond of it. "The glorious vegetation, the life free from conventionalities, and the brilliant sunlight and warmth, tempered by fresh breezes, contain some of the elements of making a paradise," and numerous lines of river-steamers afford means of convenient communication. The vegetation of this great valley is essentially different from that of the other two riverine systems. The rich, low-lying lands, subject to annual inundations, frequent rains all the year, and the continual heat, produce a vast wealth of dense tropical verdure, and a forest area greater than can be found in any other part of the globe, intersected by thousands of miles of immense navigable streams, give the region a unique character. Among the valuable vegetable productions, the India-rubber tree figures pre-eminently. It exists in such vast numbers, and the collection of the juice is so very lucrative, that it has attracted to even the most remote rivers thousands of adventurous Brazilians from the adjoining provinces, and it is doing for the Amazons what gold did for Australia and California.

The Microbe of Malaria.—Dr. George M. Sternberg has communicated to the Scientific Association of Johns Hopkins University an account of the confirmation, by his own observation, of Laveran's discovery of the germ, or micro-organism, of malaria. Laveran found this microbe in the shape of an amœboid parasite, in the blood of patients suffering from fever; and also observed that the germs disappeared from the blood when quinine was administered in effective doses. His observations were confirmed by Richard, in 1882, and by Marchiafara and Celli from their researches in the Santo Spirito Hospital of Rome. During a recent visit to Rome, Dr. Sternberg accompanied these gentlemen to the Santo Spirito Hospital, where a most satisfactory demonstration was made to him of the presence and amœboid movements of the parasite, in blood drawn from the finger of a patient in the first stage of a malarial paroxysm. Marchiafara and Celli have induced types of intermittent fever, in previously healthy persons, by injecting into the circulation a small quantity of blood drawn from a malarial patient during his fever. The presence of the parasite in the injected blood was demonstrated, and it was found again in the blood of the persons subjected to the experiment during the induced intermittent paroxysms. These paroxysms were arrested, and the parasite disappeared from the blood when quinine was administered.

Systematic Observations of the Aurora Borealis.—No country is more favorably situated for the systematic observation of the phenomena of terrestrial magnetism and the aurora borealis than Norway. Extending from the fifty-eighth to the seventy-first degree of latitude, it reaches farther north than any other inhabited land, and lies nearer to the center of magnetic disturbances than any other state of Europe. The maximum zone of the northern lights hangs over the northern and northwestern part of the land. The northern and southern districts are connected by numerous telegraph lines and through the telephone exchanges of Drontheim and Bergen. Sophus Tromholt began to organize a system of investigations in 1878, and from September of that year to April, 1879, he recorded 839 observations of 154 northern lights. His idea met with favor, and the method of concerted observation has spread since that time to Sweden, Denmark, and Finland, England, Greenland, and Iceland. The observations of the winter of 1879–'80 were much more extensive than those of the previous winter, being 1,600 in number of 249 auroras at 357 stations. In the winter of 1880–'81, 5,200 observations were made of about 300 auroras, at 675 stations; and in the winter of 1882–'83, 1,500 persons in the North European countries participated in the work. Notices are now regularly transmitted from fifty Swedish and Norwegian telegraphic stations of all electrical disturbances, with exact minutes of time, direction, etc.; observations that are of the more importance, because not a day passes

that something of the kind does not occur somewhere in Norway. Mr. Tromholt intends to publish the year's results of these observations cartographically, with notices of associated meteorological phenomena. For the complete registration of the telegraphic perturbations, he has constructed an apparatus which graphically represents the time of their happening, their strength, and direction, which is connected during the night with a north and south telegraph line 1,400 kilometres long, while during the day telephones are used. This enterprise is assuming an extent which places its effective control beyond the power of one man. Mr. Tromholt therefore proposes that the Government establish an institute at Drontheim to become the central station of the world, to which all observers on land and sea shall transmit their reports.

Importance of the Plumber's Art.—A plea for a higher recognition of the plumber has been made by Mr. William Halley in an address before the Ohio State Sanitary Association. Of the various craftsmen who assist in constructing dwellings, there is not one, perhaps, whose position in the light of sanitary science is more important and responsible than his. In days gone by he was considered a mere worker in lead to supply the simple wants of his employer, as ignorant as himself of the physical laws of his occupation; but now his work assumes the dignity of a sanitarian's. Yet there are few vocations in which skillful work is so little appreciated as that of plumbing. People are not interested in the work because it has no reference to ornamentation, and is almost wholly out of sight. A great deal depends on the plumbing. If it is perfect, the house is healthy; if imperfect, an unhealthy habitation is the result. It is easy to see that it is the most important feature of a house, to which may be added all the convenience, beauty, and polish of a palace. But first of all, stamp it with the character of health by sanitary plumbing. Even with the best devices it is impossible to prevent sewer-gas at times. There are many accidents by which plumbing-work will become crippled and allow gas to escape. Hence it is advisable to exercise extreme care about its location and quantity. Unfortunately, for the plumber and for sanitary effect, the architect is too apt to ignore plumbing and give undue attention to other matters which serve better to display his æsthetic conception. House-drainage is made secondary and subservient to convenience and display. At the last moment it is remembered that the house must be drained, and plumbing specifications are made to fill in the cubby-holes. That is why so much plumbing is worse than useless.

Foliage-Trees in Colors.—The "Saturday Review," treating of plantations of trees, dwells upon the effects that may be produced by massing those having foliage of various hues. While every garden has its "ribbon-beds" of herbaceous foliage plants, the arrangement of trees to produce similar effects is still an undeveloped art. What can be done in this line, it says, "is well illustrated at Waddeson Manor, Baron Ferdinand de Rothschild's place in Buckinghamshire. Nothing can be more beautiful than the treatment of foliage trees and shrubs in his ground. It is absolute painting, wherein the pigments are represented by golden yews (*Taxus baccata variegata* and *Taxus baccata foliis variegatis*), golden elders, double-yellow gorse, golden broom, purple barberry, purple hazel, copper beech, purple sycamore (which varies from green and gray to purple with every passing breeze), variegated maple introducing a lighter tinge, which is carried on by a mass of sea-buckthorn, whose pale, frosted silver is relieved by the deep, velvety green of a background of Austrian pine. What cannot be done when such colors as these lie ready to hand, not to mention all the 'glaucous' trees, whose leaves are often white, covered with a silky down or powdered over with a fine dust like that on a butterfly's wing? The American maples, and especially the swamp-maple with its autumn glory of foliage, have made the 'Canadian fall' or autumn a season and object of pilgrimage from all parts of the world. The swamp-maple . . . has other merits besides that of its autumn gold. In early spring the leafless branches are clothed with clusters of deep-red flowers, the young growing shoots are reddish-brown in color, and the leaves a bright, shining green above

and glaucous underneath." The white or silver maple is also named as a tree producing effects nearly similar.

NOTES.

PROFESSOR ANGELO HEILPRIN has described, in the Academy of Natural Sciences of Philadelphia, a species of cat-fish from Lake Okeechobee, Florida, which differs in several well-marked characters from other described North American species. It is most nearly related to the cat-fish of the lakes, and greatly resembles it. The largest specimen caught was about twenty inches long. The name *Ictalurus Okeechobensis* is proposed for it.

DR. DANIEL WILSON, of University College, Toronto, said in a paper read before the Royal Society of Canada, that he had concluded, after long research and discussion, that left-handedness is due to an exceptional development of the right hemisphere of the brain. Being left-handed himself, he hopes that when he is dead his own brain may be examined for the help it may give in settling this question.

MR. J. H. KERRY NICHOLS, who is well acquainted with the ground, supposes that the volcanic outbreak of June, 1886, in New Zealand, was caused by the subsidence of the crust and the sinter accumulated upon it into the vast caverns which had been excavated beneath by the solvent action of the water that brought the deposits to the top. The whole being in a superheated condition and favorable to strong chemical action, a vast explosion was the immediate result.

DR. KLEIN recently exhibited to the Royal Society under the microscope, in illustration of a paper on the etiology of scarlet fever, gelatine cultivations of the *Micrococcus scarlatina*, an organism which has been proved to be present in a certain disease of the cow and in human scarlatina.

THE programme of the coming exposition at Ekaterinburg, Russia, promises a very interesting representation of the productions and life of Siberia and the Ural. We are informed that the best time to visit the exhibition will be during July and the first half of August. A special committee will attend at the railway-station to receive visitors and give them such information as will make their expenses as light as possible.

MR. W. A. CARTER, in a recent lecture on "Marine and Fresh-Water Fishes," said that fish have the power of influencing one another by sounds and action. He had observed a shoal of carp following the lead of a single one which conducted them to a quantity of food at a considerable distance away. He had also noticed that certain fresh-water fish, such as trout, were subservient to a ruler, which might be seen swimming at the head of his tribe. The same was possibly the case with some marine forms, like the herring and bass.

A NEW and complete edition of the works of Galileo is to be published, in twenty quarto volumes of five hundred pages each, at the expense of the Italian Government.

THE sectional presidents of the Manchester meeting of the British Association, to be held August 31st, will be: Section A, Mathematics and Physics, Sir Robert S. Ball; B, Chemistry, Dr. Edward Schunk; C, Geology, Dr. Henry Woodward; D, Biology, Professor A. Newton; E, Geography, General Sir Charles Warren; F, Economic Science, Dr. Robert Giffen; G, Chemical Science, Professor Osborne Reynolds. The President of the Anthropological Section has not been designated. Professor H. B. Dixon will deliver a public lecture on "The Rate of Explosions in Gases." The lecture to the working-classes will be given by Professor George Forbes.

THE stories, once so current, that seeds taken from ancient Egyptian tombs have grown, are believed, if not demonstrably false, to lack the guarantees of truth that tales of the kind should require; and nothing as to the vitality of seeds can be built upon them. But Dr. Lindley tells of raspberries that were raised in the gardens of the Horticultural Society from seed taken from the stomach of a man who was buried in a barrow near the time of the Emperor Hadrian; and Professor Duchartre and others tell of seeds, whose identity is properly vouched for, taken from under the foundations of an old house in Paris, probably from the original soil of the island, and therefore coeval with the city, which germinated and proved to be seeds of *Juncus bufonius*, an indigenous plant of that soil.

IN dealing with a cellar in springy ground, the first thing to be done to make it dry, says "The Sanitary Engineer," is to provide some chance for the water to run away before getting into the cellar. This may be done by laying a two-inch tile drain-pipe in a trench dug all around the foundation outside of the walls, and from one foot to two feet below the cellar floor. Put this pipe together without mortar, and cover it with cobble-stones to keep out the dirt and sand. If it is not practicable to lay the drain outside, it may be laid inside of the cellar-walls, directly in the cellar-floor; but the operation of such a drain is less efficient. The back-filling of the cellar-walls should be porous enough to allow the water to go directly into the drain.

MR. G. THOMANN, of the United States Brewers' Association, has published a pamphlet to show that beer is a perfectly wholesome drink. In support of his assertion, he alleges that while brewers drink more beer, and drink it more constantly, than other people, the average death-rate among them is lower by forty per cent than that of corresponding urban populations; that their health is unusually good, with comparative freedom from diseases of the kidneys and liver; and that on the average they live longer and preserve their physical energies better than the average workmen of the United States. Mr. Thomann produces doctors' certificates showing a mean annual death-rate of 7·5 per 1,000 among 960 brewery-workmen, against 12·5 of urban population; and he talks of men drinking an average of ten pints of beer a day.

A NEW process in manufacturing iron has been tested at Pittsburg and at Southwick, Staffordshire, England, in which the metal undergoes a chemical change that is claimed to greatly improve the quality and test of the iron to whatever class it may belong. The new process is said to facilitate the running of the metal, and also increase its strength.

MR. RUSKIN, in a recent letter, has expressed his opinion of railways in a brief but most energetic manner. He says: "They are to me the loathsomest form of deviltry now extant, animated and deliberate earthquakes, destructive of all wise social habit, or possible natural beauty, carriages of damned souls on the ridges of their own graves!"

A LIMITED edition of the first volume of a series of selected morphological monographs, by members of Johns Hopkins University, is about to be issued from the publication agency of that institution. The series will be under the editorial direction of Professor W. K. Brooks. The coming number will contain three papers by Professor Brooks, and one paper by E. B. Wilson. Only one hundred copies in all of the volume will be issued.

A BULLETIN of miscellaneous information has been started at the Royal Gardens, Kew, to be published occasionally, and contain notes on economic products and plants to which the attention of the staff of the gardens may have been drawn, or which may have been made the subject of particular study there.

MR. JOHN MURRAY, of the Challenger Expedition, recently said, in the Royal Society of Edinburgh, that he questioned whether any country in the world, taking its size into consideration, could show a better record of scientific work or a greater mass of scientific literature than Scotland during the past ten or twenty years.

MEDALS and prizes are to be given this year, by the Royal Society of New South Wales, for the best communications embodying fruits of original research on the silver-ore deposits of New South Wales; on the origin and mode of occurrence of gold-bearing veins and of the associated minerals; on the influence of the Australian climate in producing modifications of diseases; and on the infusoria peculiar to Australia.

ACCORDING to a paper read by Mr. John Murray, before the Royal Society of Edinburgh, 2,243 cubic miles of rain fall annually on areas with inland drainage. Such areas extend to 11,486,350 square miles. The land draining directly to the ocean has an area of 44,211,000 square miles, of which 38,829,750 square miles have ten inches or more of rainfall. The mean discharge from this area into the ocean is 6,569 cubic miles annually. The total weight of substances carried by this means to the ocean is more than 5,000,000,000 tons each year.

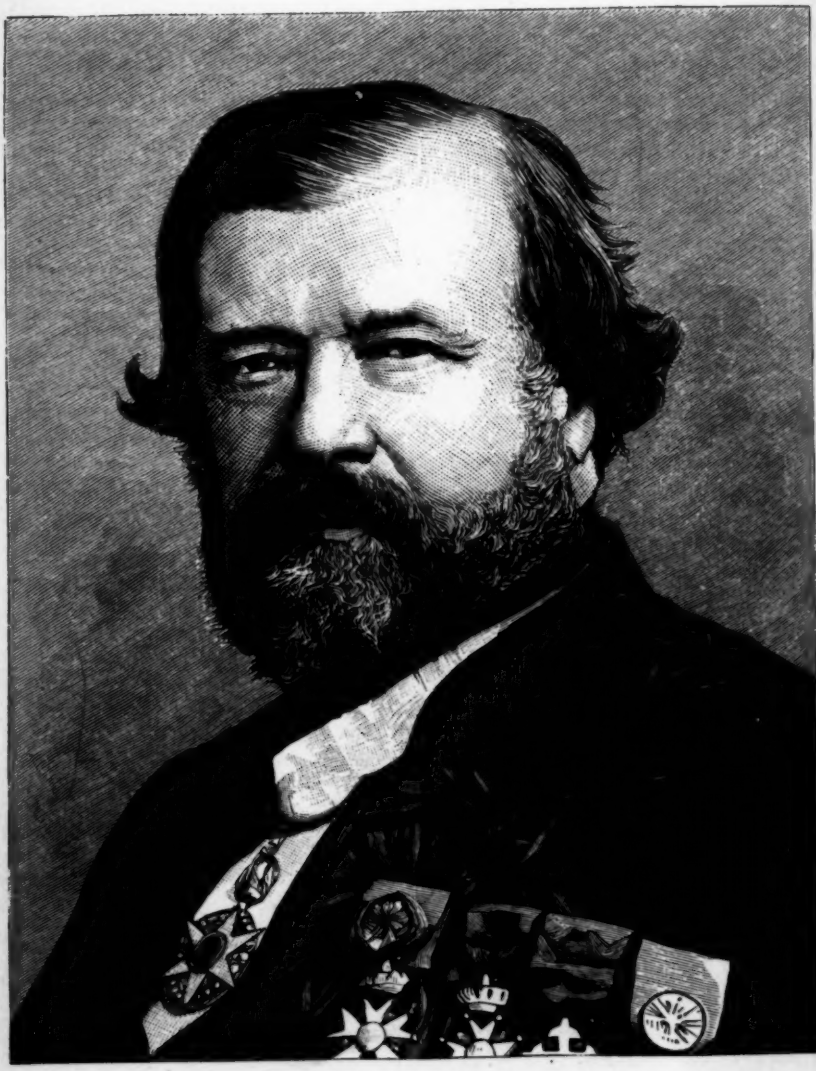
OBITUARY NOTES.

CAPTAIN JAMES B. EADS, the distinguished engineer, died of pneumonia at Nassau, New Providence, March 8th. He was widely known as the constructor of several works of great merit. Among them were the first eight ironclad gunboats owned and used by the United States, the bridge over the Mississippi River at St. Louis, and the system of jetties for deepening the channel of the mouth of the Mississippi. He had projected a plan for a marine railway across the Isthmus of Tehuantepec for carrying vessels from one ocean to the other, and was elaborating its details and seeking means for executing it at the time of his death. A sketch of his life and works, revised by himself, with a portrait, was published in "The Popular Science Monthly" for February, 1886.

DR. GUSTAV HEINRICH KIRCHENPAUER, first Burgomaster of Hamburg, and an eminent naturalist, is dead.

DR. JULIUS LÜTTICH, astronomer, and Professor Jean Louis Trasenster, both died on the 3d of January, 1887.

MR. ALEXANDER BORODIN, Professor of Chemistry in the Medico-Surgical Academy at St. Petersburg, and an eminent musical composer, died February 27th.



JULES JAMIN.